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THE EARLY DIAGNOSIS OF LEAD POISONING, WITH SPECIAL REFERENCE TO ABDOMINAL PAIN.

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With the advent of compensation for industrial diseases the profession will concern itself with an early diagnosis of lead poisoning in order to reduce the disability in such cases to give those afflicted their due consideration and to prevent malingering. Switzerland and Great Britain pay for lead disability as for accident, and for this reason have produced much accurate information for the early diagnosis of plumbism. Physicians in this State have become more and more critical in detecting lead poisoning, since compliance with the Occupational Disease Law gives a medicolegal advantage to the employer. We propose to lay down a definite standard for an early diagnosis.

From a purely scientific and humanitarian standpoint an early diagnosis is desirable in order to prevent the rapid fatal intoxications and also the sequelæ of lead, which Naegli calls meta-lead conditions, as nephritis, arteriosclerosis, cerebral hemorrhage and neurological conditions, such as paralysis, premature senility, neurosis and insanity.

We propose, in addition to this, to call attention not only to the differential diagnosis of lead colic but to the possibility of confusing milder abdominal pain from lead with that caused by abdominal conditions.

In order to effect our purpose we shall refer to three groups of lead examinations:

1. The Illinois Department of Factory Inspection has received reports of 1238 cases of lead poisoning from July 1, 1912, to July 1, 1917, but owing to the lack of specific information in early reports we can depend only on the last 934 case records, because they were made more in detail, since a list of common lead findings on the report blanks stimulated the examining physician to more careful observation and recording of the findings. These examinations were made with a varying degree of completeness by physicians throughout the State. Since there is a decided medicolegal advantage in reporting plumbism to the State Department, early diagnoses have been made and the symptoms and signs reported are early observations. Allowance must be made here and there for an absence of detail observation, since these factory examinations are often made in haste. Chart I refers to these reports.

2. Chart II refers to 72 cases of lead poisoning in which the examinations were made by the writer. In these the diagnosis is practically certain because basophilic degeneration, colic, lead tremor, lead anemia, usually in combination with constipation, were established. Very few of these cases were severe and were not of the type usually seen in hospital wards. They occurred in the lighter lead trades, such as painting, soldering, battery manufacturing and brass founding. For accuracy in deduction the writer is more inclined to use this smaller series than the larger number of cases reported in Chart I. Charts II, III and IV refer to the writer's own case records.

3. We further refer to Chart V, where the writer presents in tabulated form the results of 150 critical examinations of house painters not incapacitated but sent to the writer for the purpose of ascertaining early signs of plumbism and to furnish data for the improvement of health conditions in this trade. We have since that time examined 30 printers and 75 more painters.

The above series of examinations brings out some important points in the diagnosis of lead poisoning, since they differ from the stereotyped pictures found in the classical text-books of medicine. We hope that this paper will explain why Cabot found evidence of undiagnosed plumbism in many of his autopsies.

The lead symptom-complex is so variable that a description is difficult, as all this may be dependent (1) on the dosage and rapidity of dosage; (2) on the presence of alloys in the metals ingested; (3) on the fact whether the intoxication occurs in the form of fumes or in the inhalation and swallowing of lead dusts; (4) on the individual susceptibility, sex, age and personal habits.

There are about 150 different lead trades from which can be derived all forms of plumbism. Among painters and printers we

see mild forms, oftentimes escaping the attention of the physician, only later to be recognized as a meta-lead condition. The more severe forms are found in workers in lead smelters and white lead manufactories, where, without prodromata, the attack begins with a rapid emaciation, cachexia and colic. We recall one case in which the worker was seized with convulsions while feeding a Scotch hearth furnace without any previous complaint.

Recognizing that many workers are found ingesting and excreting lead without clinical findings we must acknowledge such early cases that the evidence of the condition is meager and that between this picture and the severer forms there are many degrees in the occurrence of the various findings and the duration of the symptoms. In speaking of the different forms of plumbism there is also a tendency among students of lead poisoning to recognize meta-lead conditions in which they observe nephritis, arteriosclerosis and brain and cord changes.

Discard the stereotyped pictures in your text-book and the typical hospital cases. Realize that the symptom-complex of an early lead poisoning is often devoid of many of the cardinal signs. Naegli, of Switzerland, has described this as the monosymptomatic occurrence of plumbism, and our findings support this view. In many forms there are no basophilic granules, no blue lines, no wrist-drop and even no anemia. Chart IV reveals cardinal findings of lead poisoning occurring oftentimes in early cases in twofold or threefold groups. The consensus of medical opinion points toward blue line, basophilic degeneration of the red cells, tremor, pallor and anemia, constipation and colic as cardinals. The data which we present substantiate this. However, the writer would prefer, instead of the common term of lead colic, the expression colic and abdominal pain from lead.

In the series of 934 cases, blue line, pallor and anemia, constipation and colic predominate, although blue line leads in the frequency of occurrence for reasons to be mentioned later. Constipation is the most constant finding, occurring 335 times, followed next by colic and anemia.

In the writer's series of 72 cases, constipation, pallor and anemia, colic, stippling, blue line and tremor are constantly observed: constipation in 81.9 per cent., tremor in 72.2 per cent., pallor and anemia in 65.2 per cent., basophilic degeneration in 51.3 per cent., pain in the abdomen of varying types in 56.9 per cent. and blue line in 26 per cent.

Considering the six findings just mentioned as cardinals it is interesting that they occurred altogether in 1 case, five times in 5, four times in 4, three times in 20 and two times in 14 cases. Chart III shows the variations of these cardinals.

In addition to these the lead-worker complains of pains in the

back, limbs and joints, probably ascribable to neuritis. This was found distinctly true in 13 cases, including 1 sciatica. Among 150 painters, 35 complained of lumbago, 42 of pains in the right shoulder, 50 of joint pains and 20 of neuralgias. The neuritis in early cases seems to affect the part most used, as, for instance, the shoulder when working with a heavy brush and the wrist when doing fine work. Strange to say we find with the hand dynamometer a paradoxical diminution in the strength of the hand most used.

Before proceeding with a discussion of the cardinals we again emphasize that plumbism is variable and that often not all the cardinal findings are in evidence.

Constipation. Constipation occurs early in the lead-worker and is quite a constant finding in this disease. Its occurrence of from 80 to 90 per cent. is to be noted in European reports as well as in the statistics of this paper. The low percentage among the factory reports occurred because many workers with blue lines were reported as lead cases when no other clinical evidence could be found, but they were inserted in the report to safeguard the employer. Among 150 painters there were 24 mild complaints of constipation, 39 moderate and 10 severe, a total of 73, or 40.1 per cent.

In severe intoxications the constipation becomes so marked that it resembles an intestinal obstruction.

Abdominal Pain and Colic from Lead. In the experience of the writer more lead-workers suffer from gastric disturbances and abdominal pain than from colic. Digestive disturbances are often prodromata to the colic. The writer recalls several painters who when they work in white lead for three or four days feel a "gnawing in the stomach," gastric disturbance, for many weeks before an actual colic occurs. The State series does not give an accurate distinction between abdominal pain and colic. In the writer's series colic occurs in 31.9 per cent. of the cases, abdominal pain in 25 per cent., a total of 56.9 per cent. In the examination of 150 house painters 46 were found with some form of abdominal pain, with digestive disturbances. These men were remarkably temperate in their habits and furnished an intelligent history. The abdominal pains and digestive disturbances are very easily confused with a chronic appendicitis, a duodenal ulcer, gall-bladder disease and other abdominal conditions. Roentgenograms in lead conditions seem to produce no pathological picture, and this serves, in a measure, to differentiate from the conditions just mentioned above.

The colic itself occurs usually as a severe abdominal paroxysm, the pain, cutting and sharp in character, crossing the abdomen from side to side, usually about from two to three finger-breadths above the umbilicus. Little mention is made of lead colic in most works on acute abdomen, and since this colic, with its intense character,

is likely to occur in any part of the abdomen, oftentimes bringing up the question of surgical interference, the writer has compiled a series of 23 cases of lead colic in which the diagnosis might suggest acute abdomen. In many of these cases the colic occurs not only about and around the umbilicus but also in the region of the bladder and of the appendix, and even resembles a renal colic. Woodard, United States Navy, in 1913, demonstrated 3 cases of typical appendix history, with a slight rigidity and tenderness over McBurney's point, which later proved to be cases of lead poisoning; 2 of them were unfortunately operated.

The colic is usually relieved by pressure or by flexing the thighs, and seems to be much out of proportion to the actual tenderness. Naegli differentiates malingering from lead colic by this fact. If in pressing or palpating the abdomen the patient cries out he decides it is not lead poisoning unless he feels assured that he is dealing with a hysteria or a marked neurasthenia. He then tells such patient that lead colic never produces such tenderness, whereupon the malingerer ceases his outcries. The writer, however, would make an exception in that type of colic which is accompanied by abdominal distention in which upon pressure tenderness and distress occur.

During the attack of the colic we notice a diminished urine, oftentimes a slow pulse, pallor, cold, clammy sweats and in about one-half of the cases vomiting.

Since lead colic is rather a common condition and may appear in any region of the abdomen, in the diagnosis of an abdominal pain not only should the hand be put under the sheets to palpate the abdomen, but in all cases should a most thorough physical examination be made from head to toes. This would not only reveal lead colic, but would, I believe, often lead to discovery of tabes, pneumonia, Pott's disease and other elusive conditions. The writer has studied the lead colic question from two standpoints—namely, the industrial and surgical—and has found in his experience that a lead colic most often resembles an acute gastritis, a gall-bladder, an appendix, the gastric crisis of tabes, angina sclerotica abdominalis and an intestinal obstruction. Reference to any standard work on the causes of abdominal pain or acute abdomen will enumerate the numerous other conditions that might be mistaken for lead colic.

It is a deplorable habit of some medical men to jump at the conclusion of lead poisoning and colic when their patient happens to be a painter or lead-worker. There is no reason why a lead-worker should not become sick with a diverticulitis, appendicitis or a Dietl's crisis. The lead-worker is also prone to attribute every abdominal pain to his trade. The writer was once called in consultation when a physician diagnosed the case as acute appendicitis, but the family had some doubt about it because the patient was a

painter. The patient had had lead colic on several previous occasions, but this time the diagnosis proved to be an appendix, marked by tenderness, rigidity, temperature and leukocytosis, and was so confirmed by the operation.

TREMOR. Tremor is often a neglected sign of lead poisoning, being very evident in the severer forms and not observed in the incipient type. With proper limitations this sign can often determine the diagnosis when stippling and blue line are absent. In the series in Chart I tremor was reported in 14.45 per cent. of the cases. Naegli found it eighty times in 140 mild cases; the writer found a fine finger tremor in 18.1 per cent. and a fine tongue tremor in 72.3 per cent.

The tremor in lead poisoning is especially fine in character, having about the same rapid vibration as the tremor of hyperthyroidism. It is fine and more rapid than the usual tremor seen in neurasthenia, nicotin and other drug conditions, and yet might be confused with these. An alcoholic tongue or finger tremor should not be confounded with a lead tremor, the former being coarse and the latter fine. The writer has seen a simultaneous lead and alcohol tremor in alcoholics, the former assuming a fibrillary twitching, especially seen along the lateral margins of the tongue.

The fact that the fine lead tremor cannot be simulated makes it a valuable sign not only for a differential diagnosis but also for detecting malingering. The tremor is a sign which appears early in many lead-workers and can be observed long before the occurrence of a colic or before the lead-worker becomes conscious of illness. Its occurrence should warn against an impending attack. Out of 150 painters a fine tremor was noticed on the tongue or on the tongue and in the fingers 56 times and a coarse tremor 40 times.

The tremor disappears slowly, often lasting for months. For this reason one ought to inquire carefully whether the tremor on its detection antedates the colic or is a sequel of it.

PALLOR AND ANEMIA. Anemia is an early sign and is usually associated with pallor, the latter being out of proportion to the actual hemoglobin estimate. The Tallquist is a valuable instrument in a lead plant. The reduction of hemoglobin in the course of monthly examinations should not be disregarded. The anemia is due to the destruction of blood cells both in the vessels and in the marrow.

An interesting article by Byfield, recently published in the *Illinois State Journal*, refers to the occurrence of pernicious anemia in the printing trade and clearly points out the effect of lead on the blood and on the blood-forming organs. In his experience the writer has seen the occurrence of five or six primary anemias in the printing trade and is at a loss to determine the cause, being in doubt whether it be a coincidence, whether it be due to lead or whether this anemia

be the result of benzol, a substance which also destroys red and white blood cells and is used in this trade. Before forming definite conclusions we feel that the matter should be more thoroughly investigated.

Blue Line. Much has been written on the blue line. The deposit of lead sulphide on the margin of the gums occurs only when there are teeth and when they are ill-kept. The line has a grayish-black tinge, the surrounding gum being somewhat bluish, as in Chadwick's sign of pregnancy. When there is doubt as to the existence of the blue line, Charles Spencer Williamson has advised the use of a hand lens. The occurrence of a blue line on the gums indicates metallic absorption and does not always indicate the use of lead, nor does this blue line indicate illness or disability, nor does its absence prohibit the diagnosis of lead poisoning. In the writer's series of 72 cases the lead line was observed in only 36.1 per cent.

Lead not only produces this characteristic phenomena on the gums but seems to destroy the teeth so that one will see lead-workers more often with decayed teeth and pyorrhea than with a lead line. In 150 painters a blue line was observed only 5 times, loose teeth 32, decayed teeth 52 and pyorrhea 32 times; only 11 painters were observed with good teeth. This condition is not seen in other trades of the same nationalities, habits and house and living conditions.

Grawitz thought that he had established the fact that all lead cases showed punctated reds; Naegli, however, found in 112 mild cases out of 169 colics 34 without stippled cells. These basophilic granules are seen in some normal persons, in cachexiæ, tuberculosis and malaria, but never in such large numbers as in plumbism. They are supposedly due to a regenerative or a degenerative process in the red cell.

Out of 50 preparations made from painters the writer found stippled cells in 12; in 72 cases reported stippling was found 37 times, or 51.3 per cent. Paul Naegli and Schnitter hold that with improved staining methods basophilic granules can be found in nearly all chronic cases of plumbism.

Naegli and Schnitter recommend the use of a methylene-blue stain. We also found greater success in the use of a Wright than of a Skelton or Giemsa stain.

To make a diagnosis of lead poisoning, Paul Schmidt states there should be 100 stippled cells out of 1,000,000 reds. Naegli insists upon counting for ten minutes before he dismisses the preparation as negative. These methods are both commendable for their accuracy. We feel that when average technic is used in examining a preparation a stippled red should be found in ten minutes, and that if none is observed the result is called negative.

Other blood findings in lead poisoning are chromatophiles in severe forms, macrocytes, microcytes and stippled normoblasts. Schnitter states that if the compensatory power of the blood-forming organs disappears, basophilic cells disappear.

Leukocytosis has been referred to as a blood finding, giving the average number of cells between 8000 and 10,000, hence a marked increase of the white cells is rare.

Subsidiary Findings. To finish our picture, reference must be made to some of the other findings in lead poisoning, as, for instance, rapid emaciation, loss of muscular strength, headaches, loss of vision, scaphoid abdomen, slow pulse, strangury, arthritis, lead paralyses of various forms, severe trembling, lead encephalopathy, anesthesiæ and hyperesthesiæ and reflex disturbances.

One word more in regard to blood-pressure which does not appear to be consistently present during an acute attack. When blood-pressure has been reported in the State reports as a high-tension pulse there may have been other factors. At least we have never observed this sign as a usual finding. The systolic blood-pressure in the examination of 150 painters was, on an average, 132 for men between 20 and 29 inclusive; 132 between 30 to 39; 143 between 40 and 49; 150 between 50 and 59; 187.5 between 60 and 69; 210 over 70. The rise in blood-pressure from lead is more liable to be a result of meta-lead condition than an actual finding during the manifestations of an acute or subacute attack.

Conclusions. From the data on hand collected and studied by the writer we present the following conclusions:

1. The manifestations of an intoxication with lead are variable, sometimes presenting only one or two of the cardinal signs of this intoxication, which are colic, constipation, blue line, tremor, basophilic degeneration of the red cells and pallor and anemia.

2. An early diagnosis of plumbism can be established by the history of lead working, by the presence of constipation, plus one or more of the cardinals: fine tremor, blue line and basophilic degeneration of the red cells. Constipation with pallor and anemia or with colic presents a suspicious picture which must be worked out by the aid of subsidiary findings.

3. Anemia and fine tremor are very early signs of plumbism.

4. As more lead-workers suffer from vague abdominal pains and gastric disturbances than from colic the differential diagnosis of any abdominal pain or colic or digestive disturbance demands the consideration of lead as the possible cause.

5. There does not seem to be a consistent rise in blood-pressure in acute or subacute cases of lead poisoning.

6. Over one-third of house painters show signs of plumbism. The high incidence of nephritis, arterial disease and pulmonary tuberculosis in this occupation must also be emphasized.

Chart I.

Out of 934 cases of lead poisoning we enumerate the findings in the number of times reported.

		Per cent.
Blue line	518	55.4
Anemia	341	36.5
Constipation	335	35.87
Colic	295	31.58
Pallor	244	25.48
Coated tongue	215	21.3
Loss of muscular strength	161	17.1
Tremor	135	14.45
Abdominal tenderness	131	14.0
Slow pulse	130	14.0
Nausea	113	12.1
High-tension pulse	74	7.9
Headache	74	7.9
Loss in weight	50	5.3
Albuminuria	27	2.88
Dyspepsia	26	2.8
Wrist-drop	24	2.57
Abdominal pain	18	1.9
Other paralyses	10	1.0
Vertigo	11	1.0

Other symptoms reported were muscular pains, neuritis, sciatica, dermatites, diarrheas, anorexia, visual disturbances, alopecia, conjunctivitis, ulcerations, rapid pulse, eructations, lumbago, metallic taste, jaundice, cyanosis, speech disturbance, ataxia, tinnitus and epileptiform seizures.

The result of blood smears were reported but not in sufficient number to warrant tabulation.

Chart II.

In a critical examination of 72 cases of lead poisoning the following symptoms and signs occurred the following number of times:

		Per cent.
Constipation	59	81.9
Stippling	37	51.3
Blue line	26	36.1
Fine tongue tremor	39	54.1
Fine finger tremor	13	18.1
Anemia and pallor	25	34.7
Pallor	8	11.1
Anemia	14	19.4
Colic	23	31.9
Abdominal pain	18	25.0
Diminished strength in hand	7	10.0
Loss of muscular strength	7	10.0
Neuritis	12	18.0
Sciatica	1	1.4
Albuminuria	2	2.8
Convulsions	1	1.4
Cerebral hemorrhage	1	1.4
High blood-pressure	1	1.4
Coated tongue	Uncertain	

Chart III.

Considering colic, constipation, tremor, anemia, blue line and stippling as the most common findings in lead poisoning they were observed in the following combinations:

Constipation, tremor, anemia	8
Tremor, stippling, constipation	7
Tremor, constipation	6
Constipation, blue line	5
Tremor, stippling	4
Anemia, constipation	4
Anemia, constipation, stippling	4
Anemia, constipation, tremor, stippling	4
Colic, constipation, tremor, anemia	3
Blue line, stippling, constipation, colic, anemia	3
Anemia, constipation, stippling	3
Colic, blue line, tremor, anemia	2
Blue line, pallor, anemia, tremor, constipation, stippling	2
Colic, constipation, tremor, anemia, blue line	2
Colic, constipation, tremor, blue line	2
Colic, constipation, blue line	2
Constipation, stippling	2
Blue line, tremor	1
Constipation, blue line, colic, tremor, stippling	1
Constipation, anemia, wrist-drop	1
Constipation, blue line, tremor, pallor, stippling	1
Anemia, stippling	1
Colic, constipation, tremor, anemia, blue line, stippling	1
Colic, constipation, tremor	1
Colic, constipation	1
Tremor, anemia, stippling	1
Constipation, stippling, colic	1
Constipation, blue line, anemia	1
Anemia, blue line	1
Tremor, anemia, blue line	1

Chart IV.

Reference to Chart III shows that the cardinal findings of lead poisoning do not appear in all cases. The following is a short tabulation of the number of times out of 72 cases in which the cardinals appeared:

All six (colic, constipation, pallor and anemia, blue line, stippling and tremor)	1
All five cardinals	5
All four cardinals	4
All three cardinals	10
All two cardinals	9

This arrangement seems to point to the fact that in early cases of lead poisoning there is more apt to be present but a few of the distinctly cardinal signs.

Chart V.

EXAMINATION OF 150 HOUSE PAINTERS—PRESENT COMPLAINTS.

	Mild.	Moderate.	Severe.
Loss of weight	18	8	5
Loss of strength	17	10	2
Nervousness	30	11	2
Malaise	5	5	2
Pulmonary—			
Cough	23	16	
Sputum	7	3	
Hemoptysis	5	3	
Night-sweats	9	6	1
Pains in chest	32	14	3
Hoarseness	..	2	
Dyspnea	6	9	5
Digestive—			
Nausea	13	3	
Vomiting	4	4	2
Eructations	4	4	1
Anorexia	19	8	5
Foul taste (mornings)	12	4	
Salivary disturbances	2		
Constipation	24	39	10
Diarrhea	5	1	
Melenæ	1		
Hemorrhoids	6	7	2
Pain in abdomen	20	25	1
Distention	6	11	
Bulimia	..	..	1
Polydipsia	..	..	3
Sensorial—			
Headache	19	20	6
Vertigo	25	10	3
Syncope	2	..	1
Spots before the eyes	25	18	1
Tightness in chest	..	2	2
Nightmare	2		
Insomnia	11	7	
Rushing of blood to head	..	1	
Loss of memory	21	21	1
Depression	1		
Confusion	2	..	1
Diminished vision	19	19	3
Diminished hearing	5	5	1
Neuromuscular—			
Neuralgias	18	2	
Joint pains	22	28	9
Pain in right shoulder	17	15	11
Anesthesiæ	1		
Paresthesiæ	2	4	
Lumbago	25	10	2
Swollen feet	..	2	1
Muscular cramps	9	4	
Trembling	3	1	
Formication	1		
Diminished strength in hands (loss of hands)	1	9	
Genito-urinary—			
Night urination	9	9	5
Incontinence	..	1	
Impotence	1	7	3
Hematuria	..	1	
Stricture	1		
Polyuria	..	2	

CHART V.—*Continued.*

General—	Mild.	Moderate.	Severe.
Festering cuts	1		
Itching eyes	17	7	1
Lacrimation	1	..	1
Tinnitus	2	2	
Heart palpitation	2	2	

PHYSICAL FINDINGS.

Appearance unhealthy	19
Pallor	26[1]
Emaciation	14
Adipose	13
Physical	8
Icteric	2
Prematurely aged	14
Loss of expression	5
Nephritic appearance	4
Scars on scalp	2
Tortuous temporals (marked)	5
Marked varicosities on face	6
Edema of the lids	2
Scleral hemorrhage	1
Dilated pupils	3
Conjunctivitis (mild except one)	11
Strabismus	1
Unequal pupils	4
Sluggish pupillary reflex	2
Argyll Robertson	3
Myopic (just by observation)	8
Corneal scar	1
Blepharospasm	1
Exophthalmos	2
Good teeth	11
Loose teeth	32
Decayed teeth with tartar, etc.	52
Pyorrhea	32
Coated tongue	19
Tongue tremor—	
Fine	56
Coarse	40
Arcus senilis	10
Laryngitis	9[2]
Bad tonsils	5[2]
Diminished hearing—	
Right ear	9
Left ear	11
Bifid uvula	1
Blue line on gums	5[3]
Foul breath	5[2]
Cervical adenopathy	12[4]
Thyroid enlargement marked	22
Thorax—	
Pulmonary findings—	
Deformities of chest	4[5]
Scoliosis	4
Abnormal dulness—	
Right apex	24[6]
Left apex	21[6]
Right posterior	12[6]
Left posterior	9

CLASS V.—*Continued.*

Thorax—	
Pulmonary findings—	
Roughened respiration in apices	15
Abnormal bronchial breathing over all lungs	22
Rales in right apex	18[7]
Rales in left apex	21[7]
Rales under axillæ	12[7]
Friction rubs	8
Cavities diagnosed	2
Heart findings—	
Hypertrophy left or right or both	49[8]
Accentuated aortic second	35
Mitral murmur systolic	7
Mitral murmur presystolic	1
Tricuspid systolic	3
Aortic diastolic	4
Rough first mitral	1
Pleuropericardial rub	1
Pulse—	
Tachycardia	10
Bradycardia	2
Irregular	2
Cyanosis	7
Marked evidence of arteriosclerosis	5
Abdomen—	
Epigastric tenderness	7
Appendicular tenderness	2
Gall-bladder tenderness	2
Liver enlargement	7
Right inguinal hernia	7
Left inguinal hernia	4
Bilateral inguinal hernia	3
Epigastric hernia	1[9]
Umbilical hernia	1[9]
Femoral hernia	1
Operation scars	5
Varicocele	1[10]
Scars uncertain	1[11]
Urethral stricture	2[12]
With active gonorrhea	4
Phimosis	4
Hydrocele	1
Hypospadias	1
One testicle	1[13]
General adenopathy	3
Skin—	
Anasarca	3
Dryness	14
Dermatitis	5[14]
Eczema	2
Acne	6
Ichthyosis	1
Dermographia	1[2]
Gouty toe-joint	2
Edema ankles	6
Varicose veins	29
Syphilitic ulcer of leg	1
Varicose ulcer	1
Epitrochlear glands	3
Swollen right knee	2
Paralysis (peripheral neuritis) in arm	1
Sign of injury	1
Flat-foot marked	1[15]
Clubbed nails marked	9
Tremor in hands	6

CLASS V.—*Continued.*

Patellar reflexes—	
Unequal	5
Exaggerated	26
Absent	3
Sluggish	2
Loss of orientation	1
Loss of expression	5
Subnormal mentality	1
General spasticity	1
Urine—	
Albumin	9
Sugar	4
Casts	16
Basophilic degenerated red cells	1
Hemoglobin estimate—	
100 per cent.	22
90–99 per cent.	64
85–89 per cent.	19
80–84 per cent.	29
70–79 per cent.	3

SYSTOLIC BLOOD-PRESSURE.

Systolic blood-pressure, average—	
20 to 29 inclusive	132
30 to 39 inclusive	132
40 to 49 inclusive	143
50 to 59 inclusive	150
60 to 69 inclusive	187.5
70 and over	210

POSITIVE DIAGNOSIS MADE.

Pulmonary tuberculosis (active)	26
Incipient or latent pulmonary tuberculosis	10
Chronic interstitial nephritis	15
Heart leakage	9
Diabetes	3
Exophthalmic goitre	1
Chronic nephritis	7
Epithelioma	1
Lead poisoning	3[16]
Tabes dorsalis	2

[1] Extreme in 3. [2] Marked. [3] Marked in 2, suspicious in 3.
[4] One very marked TB gland.
[5] One from injury the others from faulty breathing and rickets.
[6] Times. [7] Ten in both apices, 26 cases of active TB.
[8] Dilated in 7. [9] In same individual
[10] Complained of, others not perhaps noted
[11] Noticed from bubo. [12] Noted because of complaint.
[13] Removed because of TB epididymitis. [14] Chiefly hands, then legs.
[15] Many not looked for.
[16] Lead intoxication diagnosed, on the basis of chronic constipation, fine tongue tremor and anemia; constipation 73, fine tongue tremor 56, anemia 51. This makes an estimate that from 51 to 73 out of 150 men show signs of plumbism in marked cases.

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THE OPAQUE MEAL VERSUS THE STOMACH TUBE IN THE DIAGNOSIS OF GASTRIC HYPOMOTILITY.[1]

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It is generally conceded that the motor function of the stomach is of greater importance than either its digestive or absorptive. Anything interfering with its normal emptying interferes with the general process of digestion. Hypomotility, as I use the term, does

[1] Read by title at the annual meeting of the American Gastro-enterological Society at Atlantic City, May 6, 1918.

not refer to a lowered muscle tone, but a failure of the stomach, whatever the cause may be, to get a meal into the intestine within a definite time, known as normal. It is well known that stomachs differ in size and rapidity of digestion, and that a number of factors, like kind of food, size of meal, position, mental state, etc., modify the evacuation time. However, delay beyond a certain period becomes pathological. There is, as yet, no uniformly accepted procedure for determining the gastric emptying time. It is, however, common practice to consider food found in the stomach in the morning after a hearty evening meal as indicative of a severe grade of motor insufficiency. Food found in the stomach seven hours after an ordinary meal is diagnostic of the milder grades.

The roentgen-ray diagnosis is based on a residue six hours after the ingestion of an opaque meal. Unfortunately, however, no standard technic has been followed by roentgenologists. The kind and quantity of the opaque salt used differs. Some use a liquid vehicle like buttermilk or cocoa, others a more solid one like bread and milk or cereal. The amount of opaque salt varies from two to six ounces; the total amount of the meal from six to twenty. There is even no uniformity of practice in regard to eating between the first and six-hour observation, nor is the stomach always emptied previous to beginning the examination. Conclusions drawn from such diverse procedures should not be contrasted. The technic of the opaque meal should be standardized, like the Boas test breakfast.

Two years ago I reported, with Dr. Kantor,[2] 185 cases of delayed gastric emptying occurring in an unselected series of 1600 patients with digestive symptoms. I am now able to report 1000 additional cases studied both with the tube and the roentgen rays.

Technic. After a complete history and physical examination the patient presents himself in the morning fasting. The tube is introduced and the contents aspirated. The Ewald test breakfast is then administered and extracted one hour later. Occasionally the Rehfuss fractional method is employed. The roentgen-ray examination follows. The meal consists of 100 gm. of barium sulphate in 500 c.c. of buttermilk. The usual fluoroscopic and radiographic examination is made and the patient instructed to return in six hours and warned not to eat or drink in the interval. On the following day he is requested to eat a regular meal consisting of meat, potato, bread and some light dessert, the quantity to correspond with what he usually consumes at dinner and to present himself seven hours later, not eating or drinking in the interval. The object of the visit is not disclosed so as to eliminate the psychic factor. The tube is then introduced, the contents aspirated and the stomach washed out. As the stomach should be empty at this time the amount of residue determines the degree of motor disturbance.

[2] A Clinical Study of Delayed Gastric Emptying, Arch. Int. Med., 1916, xvii, 476.

Analysis of the 1000 cases showed hypomotility, with the opaque meal, 100 times, with the tube, 141. In no single instance did I fail to find some food in the stomach with the tube when any of the opaque meal was visible six hours after. Occasionally the tube rest was less than the opaque meal rest indicated. On the other hand in 41 cases the tube gave evidence of delayed emptying when the roentgen-ray method failed to discover any residue. As a rule these cases are of the milder forms of motor disurbance. However, there were 9 cases in this group with a typical duodenal ulcer history. Two of these were verified at operation. There was 1 case of gastric ulcer also proved at operation. There were 8 cases of chronic appendicitis. Four of these were operated and the diagnosis verified. I believe that chronic appendicitis is very frequently associated with a mild form of hypomotility sufficient to give a moderate seven-hour rest with a Riegel meal but none with the six-hour opaque. But besides these 41 cases there were 22 others that gave but a minimum six-hour roentgen-ray rest in which the tube showed a large rest—in one case as much as 800 c.c. and in a number of others over 150 c.c. From the above study I would conclude that the seven-hour tube test is superior to the six-hour opaque meal method as practised by roentgenologists in the diagnosis of gastric hypomotility, for in 28 per cent. of the cases it gave evidence of a rest not discovered by the roentgen-ray method and in 17 per cent. more it showed a marked hypomotility when the roentgen-ray method indicated but a slight disturbance. In both groups there were a number of surgical conditions.

I am aware that these conclusions are not in accord with those of Carman and Miller,[3] of the Mayo Clinic. They state that "During the year 1914, 950 patients who had been examined both by the roentgen ray and the test meal went to operation; 220 of these, or 23.1 per cent., showed a gastric residue at the roentgen-ray examination from the six-hour meal; 131, or 13.7 per cent., had food remnants. In other words the roentgen ray showed approximately 70 per cent. more retentions than did the clinical test meal." In attempting to explain the discrepancy between the tube and roentgen-ray findings, Carman and Miller say: "It would seem probable the time elapsing between the ingestion of the gastro-enterologist's meal and that its withdrawal is too liberal and pathological hypomotility excited." I believe this explanation hits the nail on the head. It is hardly just to compare a six-hour opaque meal residue with a fourteen- to sixteen-hour tube one. A stomach may suffer from a decided degree of hypomotility and yet manage to empty itself during the night. The six-hour opaque meal and the "fasting contents" rest may be sufficient to detect gross surgical lesions, but they are not delicate enough for all clinical purposes.

[3] The Roentgenological Determination of Gastric Motility, Arch. Int. Med., 1915, xvi, 406. The Roentgen Diagnosis of Diseases of the Alimentary Tract, Philadelphia.

For the clinician, even in the non-surgical conditions, it is important to recognize these cases of hypomotility, as they give rise to definite symptoms. The stomach should be empty of one meal before the next is introduced. The healthy stomach is capable of a great deal of abuse. It can tolerate a second meal on top of the previous one. However, the digestive juices at the end of a meal are not quite the same as at the beginning. In a stagnating stomach six or seven hours after a meal the contents are decidedly abnormal. There may be fermentation, the odor is frequently foul and rancid and abnormal products of digestion formed. Pouring fresh food into such a stomach at once leads to the souring of the fresh meal. These patients suffer from fulness, belching and a variety of toxic symptoms. They believe the food eaten at the last meal responsible for their distress. It is not the last meal but the remains of the previous one that produce the symptoms.

Harmer and Dodd[4] call attention to the difficulty of always emptying the stomach with the ordinary tube, but, despite their contention, it is my opinion that with a properly constructed tube, a proper technic and a bulb extractor the stomach can, with very rare exceptions, be emptied of its contents.

It might be suggested that the roentgen-ray method could be made more delicate by shortening the emptying time from six to four hours or even less. Or the roentgen-ray method might be combined with the Riegel method as suggested by Cole.[5] He says: "In a previous communication[6] I have already shown the fallacy of testing the gastric motor efficiency by administering bismuth suspended in fluid or mixed with cereal, and the same is true for intestinal motor efficiency. If the test is to be of value the stomach and intestines must be called upon to evacuate such a meal as is normally imposed upon them. Therefore the true test of gastro-intestinal motor efficiency is made by administering bismuth or barium, suspended in fluid, but preferably buttermilk, in conjunction with a Riegel meal of meat, potatoes and bread."

To shorten the roentgen-ray method, I believe, would be unwise, as roentgenologists, as a rule, are rather more particularly interested in the discovery of actual lesions than functional disturbances. Too much surgery is now being done on misinterpreted roentgen-ray evidence, and to shorten the time would increase the evil. I am in accord with Bassler,[7] who states: "It is apparent, whatever has been advanced to the contrary, that the method of examination by food

[4] Sources of Error in the Use of the Stomach Tube for Diagnosis: Preliminary Report, Arch. Int. Med., 1913, xii, 488.

[5] Relation of Lesions of the Small Intestine to Disorders of the Stomach and Cap as Observed Roentgenologically, Am. Jour. Med. Sc., 1914, cxlviii, 92.

[6] Die Diagnose der Boesartigen und Gutartigen Magen—und Duodenal-Laesionen und ihre Unterscheidung durch Serien-Roentgen-Aufnahmen, Ztschr. f. klin. Med., Berlin, 1914, B. lxxix, H. 5 u. 6.

[7] Some Recent Conclusions on Abdominal Roentgen-ray Work, Jour. Am. Med. Assn., 1913, p. 213.

extraction is decidedly more to be depended on in gaining an idea of exit from the stomach than is the bismuth roentgen-ray method." But the most serious objection to the opaque meal as a test for hypomotility is that these salts do not enter into the human dietary. For practical purposes it matters very little how long these substances remain in the stomach. It would seen more rational to test its motor function by giving the patient a meal he is in the habit of eating. If the roentgen-ray method simply determined the length of time that an opaque meal remained in the stomach its use could entirely be dispensed with. This could be determined just as well with the tube and the patient spared the expense and the physician the danger of roentgen-ray exposures. To accomplish this it would only be necessary to substitute the Rieder meal for the Riegel. The opaque meal could be administered as for roentgen-ray work. The tube could be introduced six hours later and the amount of opaque salts remaining could actually be measured and weighed; or, better yet, the fractional extraction method of Rehfuss could be used and the exact time the bismuth remained in the stomach determined.[8]

But the tube tells us more than that a rest is present. From the character of the residue we learn whether the patient masticates his food thoroughly; just what food is difficult for him to expel; whether abnormal products of digestion are present; whether fermentation is taking place and whether there is hemorrhage—all this information is easily obtained and is valuable in diagnosis and treatment.

It is not my intention to belittle in any way the importance of the roentgen-ray diagnosis of gastro-intestinal conditions, nor do I advocate disregarding the roentgen-ray evidence in hypomotility. It is simply my purpose to emphasize that a rational test for gastric emptying should be based on a meal of ordinary bulk and complexity which the patient should dispose of in seven hours, and that the roentgen-ray test as commonly practised is not sufficiently delicate for many clinical purposes.

APLASTIC ANEMIA.[1]

By J. P. Schneider, M.D.,

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Aplastic anemia, so named by Ehrlich in 1888, is classified by Türk among the hemolytic anemias, largely on the grounds of resemblance of one case to his Typus S and by Morawitz as an

[8] Robin uses such a meal. He administers 1 gm. of bismuth subnitrate with a simple meal in the evening and aspirates in the morning. He says: "In the normal we either find none or at most an occasional crystal of bismuth subnitrate. In cases of motor insufficiency we find in the fasting stomach many dark brown crystals of bismuth sulphate," Arch. f. Verdauungskrankheiten, 1907, 438.

[1] Read before the University Medical Society, February, 1918.

"anemia dependent upon decreased blood formation." Barker adapts the latter's classification and refers to it as an "aregeneratory or aplastic anemia of unknown origin." While in many cases this is as yet unfortunately true, there have been reported in the literature true-to-type cases in which a definite etiological factor appeared to be present. Dalton reports the type blood and clinical picture, with suppuration about the jaws, Schilling, working in the tropics, as accompanying black-water fever and sprue, while in benzol poisoning, studied clinically by Selling and imitated in animal experimentation, the brunt of the toxic effect fell without doubt upon the marrow, both leukopoietic and erythropoietic tissue undergoing destruction. In Parkes Weber's case, reported in 1914, there was at the onset gingival stomatitis, rapidly spreading on to the right cheek and there forming a definite phlegmonous induration, pyrexia and an aplastic type of anemia progressing to a rapid end in ten weeks. We cannot here, as in the acute leukemias, explain away the phlegmon by a supposed local leukemic infiltration. The postmortem examination in Weber's case showed no hyperplastic red marrow, as it should in a hemolytic infection.

During the past three decades some 60 cases of aplastic anemia have been reported. Among these are 12, with considerable evidence for the establishment of certain gross lesions as probably etiological. Sufficient evidence, Musser thinks, to warrant our definition being henceforth: an anemia secondary to marrow changes dependent upon some known or unknown cause.

In the older literature there appears frequently the conception that a fulmination hemorrhage is etiological, in that it leads to an exhaustion of the marrow. Today we are convinced that such hemorrhages are purely symptomatic. To explain away the fact that a severe hemorrhage did not lead to aplastic anemia in all instances, it was cited that the constitution of the individual determined the issue—namely, the hypoplastic individual would fail to deliver new blood in adequate measure. There are quite as many cases reported as occurring in normal-type individuals as in such as at the postmortem table give evidence of mesoblastic hypoplasia.

While etiologically we are still in the dark, there is no question of the propriety of giving aplastic anemia a separate and distinct pigeon-hole among the anemias due to decreased blood formation —clinically, hematologically, anatomically, as well as from the derived pigment studies it stands quite on its own legs. I, for one, object to referring to aplastic anemia as idiopathic pernicious anemia, aplastic variety. Pernicious anemia stands at one pole, aplastic at the other; to make of one a variety of the other is simply to introduce confusion. As an entity, aplastic anemia presents the following aspects:

1. May occur at any age, extremes reported 5.7 to 68 years. Most frequent in early adult life.

2. Sex incidence in proportion of 20 males to 15 females.

3. Rapid, non-remittent course 2 weeks to 1½ years, average 6 months.

4. Skin pale gray, not straw yellow or waxy, as in pernicious.

5. Sclera never icteric nor urine highly pigmented.

6. Strikingly leukopenia as low as 140, average below 2000, a relative increase of lymphocytes only.

7. Extraordinary reduction in blood-platelet count, often to 20 to 25 per cent. of normal.

8. The consequent presence early of a marked hemorrhagic tendency.

9. Presence of fever frequently reaching a high point.

10. No enlargement of liver or spleen.

11. No painful bone-pressure phenomenon.

12. No megalocytosis, marked poikilocytosis, polychromasia or basophilic granulation.

13. Practical absence at any stage of erythroblasts.

14. At the postmortem examination characteristic punctate hemorrhages in practically all subserous and subperitoneal surfaces and the absence of hyperplastic marrow changes.

15. Duodenal pigment values are subnormal, urobilinogen absent, urobilin less than normal and bilirubin reduced in proportion to the degree of anemia.

I wish to report 3 cases of aplastic anemia coming under my observation during the past four years:

Case I.—Female, Jewish nationality, aged twenty-six years, married. Family history negative. No severe illness in the past except measles while a child. Felt well and looked well until August or September, when the patient was observed by her friends to be pale. On November 15 she married. On December 24, at her normal menstrual period, she menstruated profusely until December 30. She became very pale. However, on December 15, the presence of bleeding gums was noted. On January 4 a severe epistaxis supervened; a tampon did not succeed in controlling the bleeding, hence the patient was sent to the hospital, and from the nose and throat clinic was referred to the medical clinic. On January 12 the bleeding was less but persistent. The intravenous introduction of gelatin apparently was followed by fever. On January 16 the patient was semicomatose, very pale—not lemon color—a peculiar dirty gray skin, especially at such places as the skin had been subjected to pressure. The gums, nasal surfaces, soft palate and skin, especially of prominent parts of the legs and arms, showed submucous and subcutaneous varicolored hemorrhagic areas. No icterus was present in the sclera. Temperature, 103°. Pulse, 120. Patient vomited; no blood, fresh or altered. Over the precordium a soft systolic murmur was noted. Both lower

lung borders were atelectatic. Spleen and liver were not enlarged. Systolic blood-pressure, 100.

Blood Examination. Blood hydremic, $\frac{1}{8}$ solid, $\frac{7}{8}$ fluid. No nucleated red cells. Platelets not counted. Red blood cells, 1,240,000; coagulation time normal. White blood cells, 1600; bleeding time prolonged. Hemoglobin, 18 per cent. Index, 0.7.

Urine. Light color; trace of albumin; no urobilinogen or urobilin.

Duodenal Contents. Duodenal siphonage revealed light yellow contents, giving no qualitative test for urobilinogen.

Stool. Guaiac, negative.

Horse serum was administered for three days, with no effect, and the patient died on January 20, less than one month after the immediate onset, with bleeding gums; however, probably five or six months after the actual insidious remote onset.

Postmortem Findings on January 20 (day of death). 1. The usual punctuate hemorrhages.

2. Persistent thymus—weight, 30 grams—apparently a status thymicolymphaticus.

3. Femur and humerus alone examined. In only the proximal one-third occasional small pink areas in an otherwise pale yellow marrow. Microscopically myeloblastic tissue, occasional normoblasts, with many of the progenitors of both the above in a state of almost unrecognizable degeneration.

4. Uterus, no lesion; small; hypoplastic. (No note was made relative to the absence or presence of hemosiderosis in the liver or the spleen.)

Case II.—This patient, an unmarried female blonde, aged seventeen years, had an uneventful family and past history, except that she menstruated scantily since the onset of this function at fifteen. Six days before entrance she began to menstruate at the proper time, but profusely; seventy-two hours later epistaxis began and the next day the gums began to ooze. Tamponage did not succeed in controlling the nasal bleeding, and the nasal seepage was rather foul.

Physical examination revealed a light-complexioned female of asthenic habitus, fairly well nourished. The scleræ were pale blue and not icteric. In all of the mucous membranes of the mouth and and throat, so far as visible, there were bleeding areas. On the legs arms under the skin there were numerous varicolored hemorrhagic areas, and from the presence of deep-lying hard areas we gather there were hemorrhages in the areolar tissues between the muscles.

Three days later this patient died in spite of many attempts to control the bleeding. No blood examination other than a rough bedside one was made. This gave a red blood count of 1,200,000; hemoglobin, 15; white blood count, 900. No postmortem was obtained.

CASE III.—This patient was seen during the past year and presented a very interesting but sad spectacle. Mrs. H., a grass widow, aged forty-seven years, American nationality, was referred to me by Dr. H. Z. Giffin, of the Rochester Clinic, on July 10, 1917. Her complaint was of weakness, palpitation and dyspnea.

Family History. Her father died at forty-nine years of dropsy; her mother at fifty-nine years of a chronic lung complaint; two brothers, one at twenty-two and the other at twenty-three years, died of phthisis; one sister, older, died of a probable phthisis. Her husband was of loose habits and had not lived with the patient for eleven years.

Past History. At ten years she had measles and pertussis. At twenty-three years she was in bed one week with what was considered a pleurisy. During the winter of 1902 she had probable epidemic influenza. During her brief married life she had no living or term child, but had one miscarriage at two and a half months. Her menstrual cycle has always been of the twenty-one day type, and that has not altered until the past two periods, when the amount has been decidedly greater. In July, 1913, a tumor was removed from her right breast. On September 29, 1913, the left breast and axillary glands were excised at Rochester. The pathological examination showed a chronic cystic mastitis. She gave no evidence of anemia at this time.

Present Illness. On April 19, 1917, she was again examined at Rochester for a sore mouth, which was stated to have begun three weeks before, following a severe "cold in the head." A Wassermann test was negative and a smear from the roof of the mouth showed the organisms of Vincent's angina. While under treatment she became pale and on May 2 her blood count was as follows: Hemoglobin, 48 per cent.; red blood cells, 3,060,000; white blood cells, 2200; color index, 0.7. Differential count: Polymorphonuclears, 4.3 per cent.; small lymphocytes, 92.3 per cent.; large lymphocytes, 3.3 per cent. Anisocytosis and poikilocytosis of slight degree.

On May 7 the hemoglobin stood at 45; red blood cells, 2,830,000; white blood cells, 1600. Differential count as above.

On June 26 the hemoglobin had fallen to 40 per cent.; red blood cells, 2,500,000; white blood cells, 1800. Differential count: Polymorphonuclears, 7.5 per cent.; small lymphocytes, 74.5 per cent.; large lymphocytes, 18 per cent. Six normoblasts were seen; also moderate poikilocytosis and anisocytosis.

Glands and spleen were not palpable and the general physical examination was negative. On May 8 a detailed neurological examination was negative.

At my first examination of the patient, on July 10, she gave the appearance of decided pallor, withal well nourished. There was no icterus of the sclera. The routine physical examination revealed

no organic findings. The spleen and liver were not palpable nor the glands enlarged. There were no petechiæ visible on the exposed mucous or skin surfaces. The blood findings of this date gave: Hemoglobin, 40 per cent.; red blood cells, 2,000,000; white blood cells, 2600; polymorphonuclears, 15 per cent.; large lymphocytes, 15 per cent.; small lymphocytes, 55 per cent. There were no normoblasts or polychromatophilia. The gastric secretory and motor function was normal.

On July 11 a duodenal contents was secured. It was at the conclusion of this procedure, after lying on her right side for an hour and a half, that the first striking clue to the type of her anemia was revealed in the nature of myriads of subcutaneous hemorrhages on all the skin surfaces exposed to the pressure of the table. These were particularly abundant in the face.

Acting on this clue a blood platelet count was immediately made revealing a count of 90,000.

The duodenal contents were secured in the amount of 40 c.c. It was dark yellow, of alkaline reaction (the acid spurts having been carefully segregated), containing no macroscopic sediment. Urobilinogen, none; urobilin, 800 units;[2] bilirubin, 2+. This, I believe, is the first quantitative duodenal pigment study done in an aplastic anemia.

Our patient was immediately sent home and put in bed and application was made for admission to the University Hospital. Two days later a profuse menorrhagia began, the control of which proved futile.

Admission to the hospital dated from July 23, 1917.

Hospital Record (Mrs. N. H.). Complaints: Anemia, weakness, loss of weight, menorrhagia, nicturia, stomatitis.

Physical Examination. Paleness of the skin and the mucous membranes; lemon-yellow color to the skin over the exposed parts. Numerous ecchymoses over the trunk and especially over the extremities. Surgical scars on the chest from the breast removal. Gingivitis; tonsils submerged, not seemingly pathological. Blowing systolic murmur heard only over the precordium and pulmonic area (hemic). Increased knee-jerks and a double short ankle-clonus. Eye-grounds: disks pale; numerous large and small hemorrhages along the course of the vessels, both inside and outside of the disks. Bleeding profuse from the uterus; uterus retroverted. Blood-pressure, 128.58. Pulse, 90 to 120. Temperature normal to 102°.

Laboratory Data. Urine entirely negative. Blood Wassermann negative. Capillary resistance low. Petechiæ after two minutes. Blood platelet count, 72,000 (August 1, 1917). No reticulated reds ever found. Blood examinations.

[2] Schneider, J. P.: The Splenic Pathology of Pernicious Anemia and Allied Conditions, Arch. Int. Med., 1916, xvii, 32.

July 27: Hemoglobin, 25 per cent.; white blood cells, 3100; red blood cells, 1,821,000.

July 31: Hemoglobin, 17 per cent.; white blood cells, 2800; red blood cells, 948,000; polymorphonuclears, 10 per cent.; lymphocytes, 44 per cent.; large mononuclears, 30 per cent.; transitionals, 6 per cent.; degenerated reds, 10 per cent.; size of reds, 7 mikra; stain of reds, pale; anisco, very slight; poikilocytosis, slight; polychromatophilia, slight; nuclear reds, none.

August 2: Hemoglobin, 24 per cent.; polymorphonuclears, 4 per cent.; lymphocytes, 6 per cent.; large mononuclears, 68 per cent.; transitionals, 10 per cent.; degenerated reds, 12 per cent.; size of reds, 7 mikra; stain of reds, pale; anisco, very slight; poikilocytosis, slight; polychromatophilia, slight; nuclear reds, none.

August 3: Hemoglobin, 12 per cent. (after transfusion, 24 per cent.).

August 6: Hemoglobin, 20 per cent.; white blood cells, 1600; red blood cells, 968,000; polymorphonuclears, 23 per cent.; lymphocytes, 26 per cent.; large mononuclears, 38 per cent.; transitionals, 8 per cent.; degenerated reds, 5 per cent.; size of reds, variable; stain of reds, pale; anisco, none; poikilocytosis, slight; polychromatophilia, none; nuclear reds, none.

August 7: Hemoglobin, 15 per cent.; red blood cells, 850,000.

August 9: Hemoglobin, 12 per cent.; white blood cells, 1400; red blood cells, 768,000; polymorphonuclears, 8 per cent.; lymphocytes, 42 per cent.; large mononuclears, 47 per cent.; transitionals, 3 per cent.; size of reds, normal; stain of reds, pale; anisco, none; poikilocytosis, slight; polychromatophilia, none; nuclear reds, none.

Important Therapeutic Data. Ergot, calcium, blood serum and whole serum given on several occasions. Blood transfusion, 300 c.c. (citrate method) on August 3, and again 400 c.c. on August 6, with reaction. (Temperature, 103°; pulse, 140.)

Patient died August 10, 1917, four months and ten days after the abrupt onset of what appeared to be a trivial unknown infection of the upper air passages.

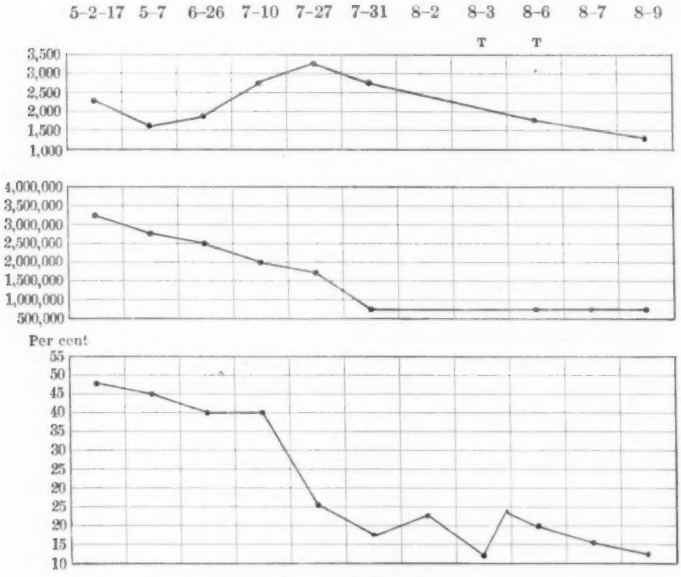
The postmortem data were as follows:

Body well nourished, weighs about 150 pounds. No edema. Skin very pale, with faint yellowish tinge. Small subcutaneous hemorrhages over left arm and both thighs. Subperitoneal hemorrhages on the anterior parietal peritoneum and on the diaphragmatic peritoneum. Old pleuritic adhesions on the left side; 200 c.c. of thin straw-colored fluid in the left pleural cavity; 500 c.c. of similar fluid in the right cavity. The pericardial cavity contained about 75 c.c. of straw-colored fluid. There were a few subpericardial hemorrhages on the right auricle. The heart weighed 300 grams. Musculature was light yellowish brown and rather soft. Areas of fatty degeneration of the muscle under the endocardium, giving a "tabby-cat" appearance. Normal valve leaflets. Lungs, small

amount of bronchopneumonia. Spleen weighed 160 grams. Smooth capsule. Rather firm reddish-brown pulp. Liver weighed 1400 grams. Cut surface light yellowish brown in color. In the kidneys there were no gross changes except some submucous hemorrhages in the pelves. There were several cysts in the ovaries. No examination of the head or the long bones.

Microscopic examination of the spleen showed in nearly all the follicles some areas of hyaline degeneration of the stroma. The arteries are apparently not involved.

CHART SHOWING VARIATIONS OF WHITE BLOOD CELLS, RED BLOOD CELLS AND HEMOGLOBIN IN CASE III.



Transfusions are indicated by T.

SUMMARY. 1. All three of these cases of aplastic anemia occurred in females.

2. Two were definite asthenics, with a 30-gram thymus at the age of twenty-six years in one. One was of normal habitus.

3. A definite history of a remote stomatitis or "cold in the head" is absent in 1 and 2 but present in 3. Between this and the fulminating onset with hemorrhagic symptoms there was a period of three and a half months of progressive anemia in 3, and this period of insidiously but rapidly developing anemia was also present in 1 and 2.

4. In Case III, in the Rochester reports of the May 7 blood examination, a half-dozen normoblasts were seen. This is exceptional, but occurs in one other reported case of Türk's series.

5. All three had a marked leukopenia, increasing in degree toward the end.

6. The platelet count was low but no definite figures were preserved in Case I. In Case II no blood examination was made. In Case III, 90,000 and later 72,000.

7. All three were free of clinical evidence of excessive blood destruction: pale sclera, pale urine and small liver and spleen.

8. At the postmortem examination of Case I the marrow of the long bones presented no hyperplastic attempts. No note is made of the spleen and liver. In Case III, while the long bones were unfortunately not examined, the spleen and liver were less than normal in size in an otherwise well-nourished individual.

9. The duodenal contents were qualitatively studied in Case I, urobilinogen being absent and the gross color excluding an abnormal amount of urobilin. In Case III the values obtained in the duodenal contents were precisely those found in a non-hemolytic anemia, an oligochromia. In a pernicious type, with a count of 2,000,000, the duodenal values of urobilin and urobilinogen would have been several thousands units. The H–H index[3] of 0.46 speaks for a total absence of marrow delivery. That the hemosiderosis occasionally reported present in the liver in aplastic anemia is not due to hypersplenismis probable from these values. That it is due to absorption of extravasated blood from the various hemorrhagic areas is probable, but remains to be proved. A duodenal pigment study is advisable in the differential diagnosis of aplastic as against the hemolytic anemias.

10. Table I represents graphically the progressive downward course of the disease uninfluenced by transfusion.

11. The hemorrhagic feature, distinctly purpuric in character, is linked up with the reduced platelet supply, Hurwitz's studies having shown the parallelism existing between the platelet count and bleeding time. The fragility of the vessels themselves is less easy of comprehension.

12. Viewed in the light of the above findings and influenced by the postmortem observations of Engel and Hirschfeld, I feel that proper emphasis should be placed upon the fact of toxic marrow destruction, in a reconsideration of the terms by which this disease is known. Aplastic anemia implies congenital defect. Hypoplastic and aregeneratory imply poorly developed marrow readily failing on demand. A better term would be toxic paralytic anemia or toxic anhemopoietic anemia.

[3] Schneider, J. P.: Further Quantitative Study of the Duodenal Blood-derived Pigments, Arch. Int. Med., 1917, xix, 1.

[4] Ueber aplastiche Anämie, folio Hematol., Leipzig, 1911, xii, 347–362.

THE DIAGNOSIS AND TREATMENT OF DIAPHRAGMATIC PLEURISY: WITH REPORT OF CASES.

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For many years it has been noted that not infrequently a pneumonia begins with symptoms resembling acute abdominal disease, particularly in children. J. P. Crozer Griffith[1] reported several cases, as did also Herrick[2] and others. Needless to say, many clinicians have suffered the experience of advising operation for some acute intra-abdominal condition, only to find the abdominal contents normal and a pneumonia in one of the patient's lower lobes the day following the operation.

To Capps[3] we owe the well-defined picture of involvement of the diaphragm by inflammatory processes. He published in 1911 the results of experimental irritation of the diaphragmatic pleura in a series of human beings, the work being done upon patients with pleural effusions. Irritation of the diaphragm was accomplished by means of a wire introduced through a trocar inserted into the pleural cavity preparatory to the withdrawal of the pleural effusion. His observations covered experiments upon 75 patients, only 35 of whom presented favorable conditions for free exploration of the diaphragm. He also presented in the paper a very complete discussion of the previous work, which has been published upon the innervation of the visceral and parietal pleura.

He concluded from his experiments that:

1. The visceral pleura is not endowed with pain sense.

2. The parietal pleura is richly supplied with sensory fibers from the intercostal nerves and irritation of it produces pain that is accurately localized by the individual over the spot that is touched. Such irritation never gives rise to "referred" pain in the neck or elsewhere.

3. The diaphragmatic pleura receives its nerve supply from the last six intercostal nerves, which supply a peripheral rim of the diaphragm two or three inches wide anteriorly and laterally and a segment corresponding to the posterior third, and from the phrenic nerve which supplies the central portion of the diaphragmatic pleura.

The pain produced by irritation of the central part of the diaphragmatic pleura is a true referred pain, and is distributed over the skin and tissues supplied by the third and fourth cervical segments, with a predilection for the trapezius ridge.

The pain elicited by irritation of the peripheral or posterior portion of the diaphragmatic pleura is also a true "referred" pain. The pain is usually distributed in segmental areas over the lower thorax and epigastrium, sometimes extending downward over the whole abdomen on the same side (seventh to twelfth dorsal segments).

Both pains are spontaneous and are associated with hyperesthesia and hyperalgesia of the skin and superficial tissues on pressure.

4. The pericardial pleura receives its innervation chiefly, if not exclusively, from the phrenic nerve. Irritation of this part of the pleura results in "referred" pain in the neck of the same character as that following irritation of the central portion of the diaphragmatic pleura.

This work offered a definite starting-point from which to work in the diagnosis of involvements of the diaphragmatic pleuræ, and in 1916 Capps[4] published a series of 61 cases of diaphragmatic pleurisy, in all of which the diagnosis was confirmed either by autopsy or the subsequent history of the cases. In this article he called attention to the various distributions of the referred abdominal pain, and emphasized the points of difference between it and the pain of true abdominal disease.

The skin and muscles of the abdomen are more sensitive in referred pain from the diaphragmatic pleura than in abdominal visceral disease, and the cutaneous reflexes are more lively in referred pain. Deep pressure with the flat hand is better born in referred diaphragmatic pain, while it produces deep pain over an inflamed organ within the abdomen.

The presence of sharp localized pain in the neck, occurring spontaneously or only on pressure, on the same side as the abdominal pain often suggests the true state of affairs, as it indicates irritation of the phrenic nerve. The referred pains in the neck and abdomen are often aggravated by cough or deep breathing.

Also, in acute diaphragmatic disease there are usually present evidences of respiratory infection, such as cough, expectoration, herpes labialis, rapid respiration, high leukocytosis, etc. According to Capps, hiccough is not common in diaphragmatic disease, as was formerly supposed, having occurred only five times in his 61 cases.

The differential diagnosis of involvement of the diaphragmatic pleura and abdominal disease is very important, and at times the clinician is in a veritable whirlpool of indecision concerning the correct diagnosis. We have had the opportunity in the past two years of observing in the Cincinnati General Hospital and the Wilhelm and Gette Beckman Dispensary a number of patients

exhibiting some or all of the features mentioned by Capps in his description of diaphragmatic pleurisy. In certain of these cases the question of surgical intervention was quite acute and the importance of correct diagnosis therefore correspondingly great.

From these cases we have selected 22 in which the diagnosis was confirmed either by their future course or at the autopsy table, and are presenting them, hoping to show the variations in the manifestations of diaphragmatic pleural disease and the different paths by which we arrived at a diagnosis in the different instances. The accompanying table shows the symptoms, both subjective and objective, that were found in our cases. (See Figs. 1, 2, 3.)

Of these 22 cases 10 were acute in character, 3 had acute exacerbation at the time of observation and 9 were subacute or chronic. The following cases in the first group resembled surgical conditions so closely that the question of operative intervention was seriously considered:

No. 1, renal stone; No. 4, acute cholecystitis; No. 6, cholelithiasis with colic; No. 8, generalized acute peritonitis from perforated typhoid ulcer; No. 14, operation was done for an acute appendicitis, much to our chagrin; Nos. 18 and 22 both had operation for gall-bladder disease several years previous to the time of observation. In both cases neither stones nor any other pathological condition were found at operation, and shortly afterward there was a recurrence of the symptoms that had existed before the operation. In the remaining cases of the acute group the symptoms or history immediately gave an inkling as to where the seat of the trouble lay.

In the group of chronic types the question of surgical treatment arose in No. 7, which is interesting because it combined definite symptoms of diaphragmatic pleurisy and a chronic appendicitis, which were both proved by the further history of the case. In the acute cases the symptoms arose suddenly, as with the onset of pneumonia, and after several weeks practically all the symptoms had left. On the other hand, in the chronic cases, the onset was acute and the symptoms subsided, but at irregular intervals there was a recurrence of the symptoms, in whole or in part, usually without an increase in temperature and not with the original acuteness. At these periods of recurrence exertion and cough intensified the symptoms, and frequently exertion was the cause of the recurring attack. The chronic sufferers complained just as bitterly of the pain and, occasionally, of the hyperesthesia as those who suffered from an acute attack.

Hyperalgesia and hyperesthesia were not always marked, being present in 7 cases. The hyperesthesia, when present, was most acute, and one of the patients cried out when the tips of the fingers were passed over the skin. In one patient clothing was almost unbearable. The involvement in hyperesthesia was usually over a large area. (See charts.) Hyperesthesia and hyperalgesia were

Number.	Sex.	Age.	Hyperesthesia and hyperalgesia.	Referred pain.				Hiccough.	Acute.	Chronic.	Nausea.	Vomiting.	Friction sounds.	Pneumonia.	Temperature.	White blood cells.	Polymuclears, per cent.	Roentgen rays.
				Abdominal.	Neck.	Beneath twelfth rib.	Elsewhere.											
1	M.	48	..	×	×	×	.....	×	×	..	×	..	..	×	100.4	22,000	Increased	Definite.
2	F.	15	×	×	×	×	Over dorsal spinous processes	..	×	..	..	..	..	..	100.4	20,000	93.0	Definite.
3	M.	28	..	×	×	×	.....	..	×	..	..	..	×	×	101.6	20,000	88.0	Definite.
4	F.	55	..	×	×	×	.....	..	×	..	..	..	×	..	103.6	11,800	68.0	Not definite.
5	M.	52	..	×	×	×	.....	..	×	..	..	..	×	..	98.6	5,500	77.5	Definite.
6	M.	40	..	×	×	..	..	..	Exacerbation	×	..	..	..	..	99.0	4,100	79.0	Definite.
7	F.	31	..	*	×	×	.....	..	.....	×	..	×	..	..	99.0	8,000	80.0	Not definite.
8	M.	19	..	×	..	..	.....	..	×	..	..	..	..	×	105.0	12,800	79.0	
9	M.	36	..	×	..	..	.....	×	×	..	..	..	..	×				
10	F.	36	..	..	×	×	.....	..	.....	×	..	..	..	..	99.6	...	....	Definite.
11	M.	45	..	×	×	×	.....	..	.....	×	..	..	..	..	...	...	....	Definite.
12	M.	40	×	..	×	×	Over dorsal spinous processes	..	.....	×	..	..	..	..	...	...	...	Definite.
13	F.	23	..	×	×	×	.....	..	.....	×	..	..	..	..	...	...	....	Definite.
14	M.	36	×	×	..	..	.....	..	×	..	×	×	..	..	101.2	13,200	54.0	Definite.
15	M.	38	×	×	×	×	.....	..	×	..	..	..	×	..	100.0	13,500	....	Not definite.
16	M.	38	×	×	×	×	.....	..	×	..	..	..	×	×	102.6	15,200	Increased	
17	M.	32	×	×	×	×	.....	..	×	..	..	..	..	..	100.2	...	....	Not definite.
18	F.	35	×	×	×	×	.....	..	Exacerbation	×	..	..	..	..	99.0	8,800	Increased	Definite.
19	F.	14	..	×	×	..	.....	..	.....	×	..	..	×	..	101.2	12,200	70.0	
20	M.	43	..	×	×	×	.....	..	×	..	..	..	..	..	101.6	9,600	61.0	Definite.
21	M.	46	..	×	×	×	.....	..	×	..	..	..	×	..	101.0	6,800	....	Definite.
22	F.	38	..	×	×	×	*	..	Exacerbation*	×	..	..	..	..	99.2	14,200	....	Definite.
Summary		..	7	19	19	17	.....	2	13+ 3 exacerbation	9	2	2	7	5	...	...	....	Fourteen definite.

* Doubtful.

much more apparent in the acute than in the chronic cases as a rule. In the great majority of cases deep abdominal pressure was borne quite well. Spontaneous pain was not always present in the neck when pain on pressure was marked.

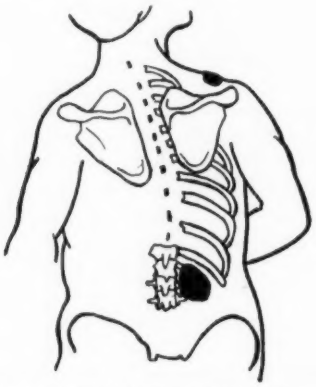

FIG. 1.—Case 1. Showing points of tenderness along the trapezius and beneath the twelfth rib posteriorly.

The two most constant areas of tenderness on pressure were below the twelfth rib posteriorly on the affected side and at the ridge of the trapezius, though the patients did not always complain of

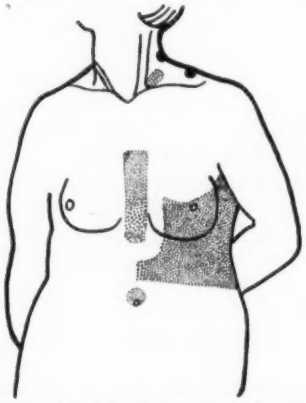

FIG. 2.—Case 2. Showing points of tenderness along the trapezius, in solid marking, and the stippling showing areas of hyperesthesia and hyperalgesia.

spontaneous pain at these points. The upper quadrants of the abdomen were the most frequent sites of the referred abdominal pain. In many of the cases the abdominal pain radiated toward the

flanks, and in two of them there was definite tenderness, involving the entire half of the back from the lower ribs to the ilium. There was usually moderate rigidity and muscle spasm of the abdominal muscles at the areas of referred pain. Abdominal symptoms of

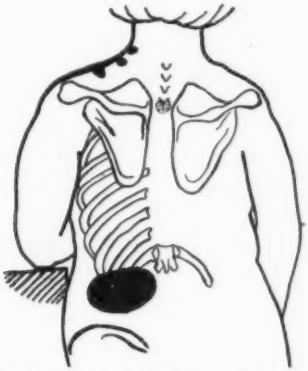

FIG. 3.—Case 3. Showing points of tenderness along the trapezius posteriorly and tenderness beneath the twelfth rib and an area of hyperesthesia over the fourth dorsal spinous process.

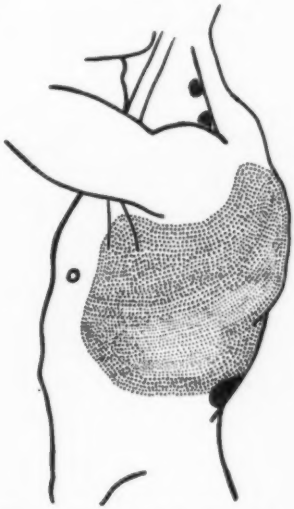

FIG. 4.—Case 12. A lateral view showing areas of hyperesthesia and points of tenderness along the trapezius and beneath the twelfth rib posteriorly.

varying degree were present in 19 of the 22 cases. In 2 cases there was board-like rigidity over the abdomen. One was operated for relief of acute appendicitis and the appendix was found apparently

innocent of any disease. In the other case (No. 8) the rigidity and muscle spasm continued until there appeared definite signs of consolidation in the left base. This is the only patient who died, and at autopsy the pathologist reported: "In the left pleural cavity

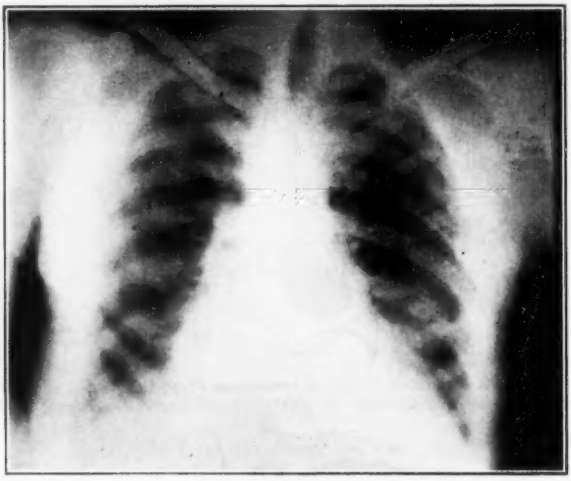

FIG. 5.—Case 1. Roentgen-ray plate showing small area of infiltration over left diaphragm.

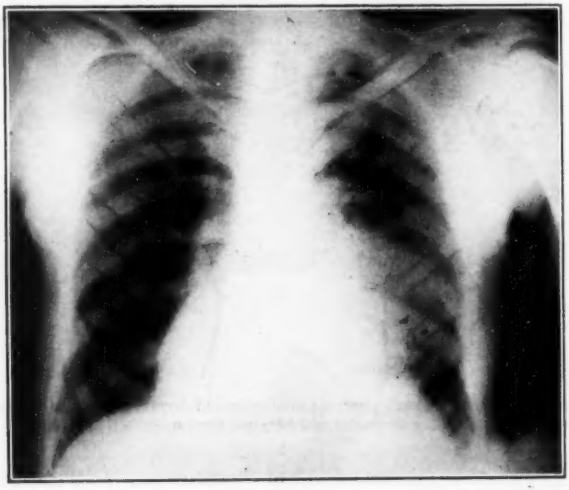

FIG. 6.—Case 1. Showing a definite area of infiltration six days after the first picture was taken.

there were a few acute fibrinous adhesions over the left lower lobe and no fluid. The pleural surface of the left side of the diaphragm

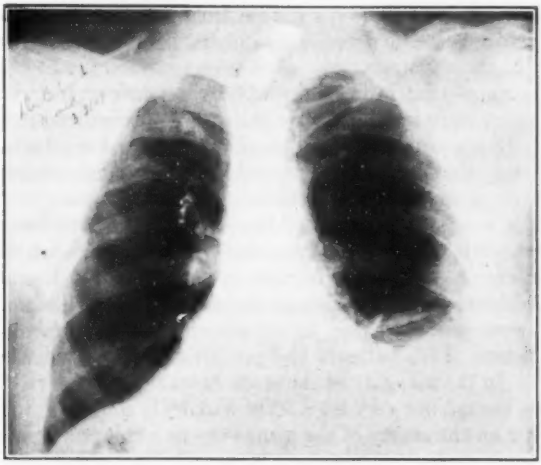

FIG. 7.—Case 6. Showing the position of the diaphragm and markings of the right lower base. One month after this plate was taken another pair of stereoscopic plates "failed to show the shadows at the right base which were seen on the previous plates."

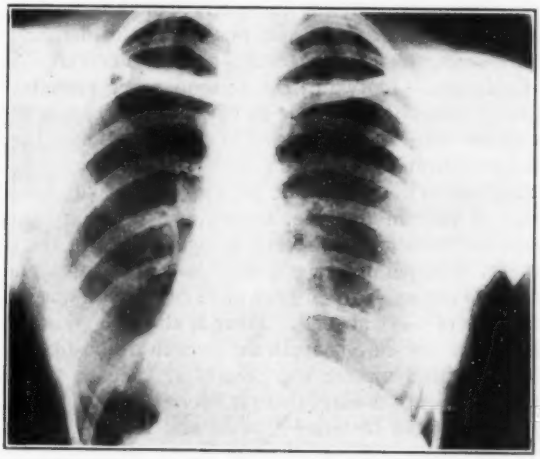

FIG. 8.—Case 13. Showing distortion of the left diaphragm by adhesions.

was congested and had about its middle point and extending posteriorly from this a small amount of fibrin, some of which was under-

going organization. Beneath this and surrounding it there was exceedingly well-marked venous congestion. The peritoneal surface of the diaphragm showed nothing but slight congestion. The lower lobe of the left lung showed a diffuse lobar consolidation, and all of the bronchi of this lobe were filled with pus. There were no abnormal findings in the abdomen."

Capps states that in his series of 65 cases hiccough appeared in only 5 cases, while in our 22 cases this symptom occurred in 2 cases, and in both was quite intractable, all of the usual methods for its relief failing, the hiccoughs apparently ceasing spontaneously.

Fourteen of our cases were males and 8 were females. Gastric symptoms were not frequent. One case showed both nausea and vomiting, while nausea and vomiting were present, each once, in separate cases. In 7 cases friction sounds were heard, practically all in the lower axillary region of the affected side. These friction sounds were probably due to an associated involvement of the costal pleura. Five patients had pneumonia associated with their pleurisy. In the majority of the acute cases there was a rise in temperature, though not very high. The leukocyte count was increased, depending on the acuity of the symptoms as a rule; associated with the increase in leukocytes there was a proportionate rise in the polymorphonuclear neutrophile cell count.

In but 4 of the 19 cases examined by the roentgen rays there were no findings suggestive of pleural or pulmonary involvement. The roentgen-ray findings varied, ranging from definite distortion of the diaphragmatic contours to merely a definite increase of the hilum markings radiating to the border of the diaphragm. In several instances, shadows suggesting calcification were lying close to the diaphragm. In two of the accompanying reproductions of roentgen-ray plates one can see in the early picture a finger-like infiltration above the diaphragm and in the latter picture the shadow of a definite infiltration of the lung in the same region.

The diagnosis of diaphragmatic pleurisy was usually made on the occurrence of pain in the side, associated with pain beneath the twelfth rib on the affected side and along the edge of the trapezius on that side. The pain may be spontaneous in the neck and was so in one-third of our cases. In 19 out of 22 cases there was tenderness along the edge of the trapezius. There is almost a constant finding of tenderness on pressure beneath the twelfth rib posteriorly on the affected side; this symptom was present 19 times in 22 cases. In the vast majority of the cases there is referred pain in the abdomen, with varying degrees of muscle spasm and rigidity. A moderate rise in temperature with an increase in the leukocytes and polymorphonuclear cells is usually present. In some cases there are heart friction sounds in the lower axilla.

The roentgen-ray examination of the chest in over three-fourths of the cases did *show* definite diaphragmatic involvement or pulmonary involvement close to the diaphragm.

In chronic cases there is exacerbation of the characteristic symptoms on exertion, cough and frequently on deep inspiration.

TREATMENT. In the acute cases the treatment is that of any pleuritis. We have found that cold applications, in the form of iced-linen strips, applied (and frequently changed) to the affected side for two hours, is most efficacious. Of course, sedatives are used when necessary. Strapping the lower chest and upper abdomen seems to give the greatest relief, and many of our chronic cases return to us asking that their sides be strapped. They have found that after the side has been strapped their pains will be relieved almost immediately and that they will be free from their annoying symptoms for from several weeks to months.

We are indebted to Mr. R. Isaacs for the accompanying charts.

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THE FRACTIONAL EXAMINATION OF THE DUODENAL CONTENTS.[1]

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THE duodenal contents are of intrinsic value for the welfare of the organism. The main process of digestion is accomplished by the proper working and correlation of the different fluids entering into this comparatively small part of the digestive apparatus (the duodenum). It is quite natural that a study of these secretions from every possible viewpoint will prove useful physiologically as well as pathologically.

In several previous communications I published my results concerning the examination of the duodenal contents. Usually these explorations of the duodenal secretions had been done either in the fasting condition of the patient or some time after the ingestion of either tea and sugar or bouillon. No particular attention had been paid as to the length of time after the meal the examination had been performed.

It appeared to me worth while to undertake a comparative

[1] Read before the Association of American Physicians, at Atlantic City, N. J., May, 1918.

study between the results of the examination in the fasting condition and at different periods after certain test meals. Inasmuch as the duodenal tube must have a comparatively narrow lumen, solid food, even mechanically well comminuted, would be apt to clog up the instrument, and would therefore be inappropriate for these examinations.

For these reasons I had already formerly employed either tea and sugar or bouillon as preparatory meals.

In the present investigation I selected a cup of beef bouillon (one bouillon cube, usually Armour & Co., to one cup of hot water) as the proper test meal. Beef being a strong stimulant for the digestive secretions seemed to answer well our purpose.

Examination of the duodenal contents was first made in the fasting condition, then a cup of beef bouillon was given by mouth and the duodenal contents aspirated every half-hour for a period of two hours (fractional examination).

In order to have a larger collection of cases, we utilized many patients who were on duodenal alimentation or duodenal fluid instillation for this purpose. In these cases the explorations can be carried out with the greatest ease, for they have the tube already in the right place. But we also took patients not accustomed to the tube, principally in conditions in which the bile or pancreatic secretions had to be examined any way. We also had two persons without any subjective symptoms, representing the normal, who were willing to undergo this examination for the benefit of science (George C. and Miss Ruth M., to whom I express my thanks for coöperation).

In all these additional cases the mode of procedure was as follows: The patient was given the duodenal tube in the evening after a light supper. Attention was paid to the length of tube which had entered the buccal cavity before retiring. Mark III of the tube should have reached the mouth; if not, the patient is given milk or water and the tube in this way made to go in beyond the III mark before going to sleep. In patients who sleep restlessly it is advisable to attach the tube, lying outside the mouth, with a piece of adhesive plaster to the cheek, in order to avoid a pulling out of the instrument during the night by any inadvertent motion. In the early morning the capsule end of the tube has usually reached the duodenum and the desired examination can be performed.

The specimens obtained were examined within one or two hours after aspiration. The quantity and appearance of the fluid, in regard to color and clearness, then the reaction, whether neutral, alkaline or acid, and the figure of alkalinity or acidity, were ascertained. For the reaction, blue and red litmus paper was used, while the degree of alkalinity was determined by titration, with methyl-orange and $\frac{1}{10}$ standard solution of hydrochloric acid. The ferments (amylopsin, steapsin and trypsin) were estimated by

employing agar tubes[2] and gauging the amounts by the digested piece of the agar column, stated in millimeters. I am greatly obliged to Dr. O. Hensel for having examined seven specimens from my cases.

Altogether, I have examined the duodenal contents of thirty-two people with the fractional method. In all the bouillon test meal was used; in most of the patients the duodenal contents were also examined in the fasting condition. It will be best to first give the results of these examinations in table form.

REMARKS. The table on pages 820–826 begins with two apparently normal individuals (Group I). In Case 1, R. M., the alkalinity of the duodenal contents in the fasting condition is 30 while one-half hour after the bouillon test meal it is only 10, then it goes to 25, 25 and ultimately to 30. The ferments, likewise, are strongest in the fasting condition while they are weakest one-half hour after the test meal, to increase in strength later on.

Case 2, also belonging to the apparently normal, shows already a different relation. Here the alkalinity in the fasting condition is 20; half an hour after the test meal it is the same. The ferments in the fasting condition are weaker than half an hour after the bouillon; one hour after the test meal they are strongest while later the steapsin ferment grows weaker.

Group II. Five cases with normal gastric secretion, HCl+, acidity 60. In A. M., R. S. and J. M. W. the alkalinity increases up to the end of the first hour, it then slightly diminishes. In Mrs. T. T. and W. B. the alkalinity shows a steady increase up to the end of the two hours.

The ferments show great variations, but, on the whole, their strength, on an average, is greatest about one hour after the bouillon test meal.

Group III. Eleven cases of hyperchlorhydria, in three of which the fasting duodenal contents were examined, show in two a slightly diminished alkalinity one-half hour after the bouillon test meal, while in one there was apparently no difference.

The figures of the alkalinity fluctuated between 5 and 40 and were usually highest between one hour and one and a half hours after the bouillon test meal. The ferments, likewise, showed, in a general way, the same peculiarity, being strongest about that time.

Group IV comprises 4 cases of subacidity and 1 of cholelithiasis, with unknown gastric secretion. The degree of alkalinity fluctuated between 10 and 35; once it was 70 and once in the same patient, with the biliary fistula, it was found to be acid or −10. The strength of the ferments was usually highest between one and a half hours after the bouillon test meal.

[2] Einhorn, Max: Agar Tubes for the Estimation of the Pancreatic Ferments, Med. Record, January 15, 1910; also Recent Studies of Pancreatic Secretions, Med. Record, January 12, 1915.

TABLE OF CASES IN WHICH FRACTIONAL EXAMINATIONS OF THE DUODENAL CONTENTS WERE MADE.

No.	Name.	Diagnosis.	Gastric contents.	Date and time.	Duodenal contents.					Remarks.
					Quantity and appearance.	Alkalinity.	Amylopsin.	Steapsin.	Trypsin.	
				GROUP I.						
1	Miss R. M.	Apparently normal	½ h. a. b., HCl+; ac., 30 1¼ h. a. b., HCl+; ac., 40	March 3, 1918 Fasting	1½ c.c.; yellow; turbid	30	8	5	5½	
				½ h. a. b.	2 c.c.; straw yellow; slightly turbid	10	4	1	1	
				1 h. a. b.	2 c.c.; yellow; golden tinge; slightly turbid	25	7	3	5	
				1½ h. a. b.	2 c.c.; yellow; turbid	25	6½	4	5	
				2 h. a. b.	2½ c.c.; yellow; slightly turbid	30	7	4	5½	
2	Mr. G. C.	Apparently normal	½ h. a. b., HCl+; ac., 50	Mar. 17, 1918 Fasting	4 c.c.; yellow, very slightly turbid	20	7	Tr.	6	
				½ h. a. b.	6 c.c.; golden brown and clear	20	10	2	7	
				1 h. a. b.	4 c.c.; golden yellow and clear	25	12	2	6	
				1½ h. a. b.	3 c.c.; straw yellow and clear	20	9	1	5	
				2 h. a. b.	6 c.c.; golden yellow	35	12	1	7	
				GROUP II.						
	Mr. A. M.	Cholecystitis; chronic appendicitis	HCl+; ac., 60	Feb. 21, 1918 Fasting	3 c.c.; turbid; green, yellow	20	10	25	4	
				½ h. a. b.	3 c.c.; turbid; green, yellow	20	9	4	5	
				1 h. a. b.	3 c.c.; yellow; slightly turbid	30	4	0	Tr.	
				1½ h. a. b.	2½ c.c.; yellow; very slightly turbid	10	5	Tr.	1	
				2 h. a. b.	2½ c.c.; clear; straw colored	10	4	Tr.	3	

4	Miss R. S.	Nervous regurgitation	HCl+; ac., 60	Feb. 5, 1918					
				½ h. a. b.	6 c.c.; yellow	5	0	½	½
				1 h. a. b.	6 c.c.; yellow	15	4½	1½	2½
				1½ h. a. b.	2 c.c.; yellow	10	6	1½	1
				2 h. a. b.	1½ c.c.; yellow	10	0	1	Tr.
5	Mr. J. M. W.	Duodenal ulcer	HCl+; ac., 60	Oct. 30, 1917					
				½ h. a. b.	Yellow; cloudy	40	5	½	Tr.
				1½ h. a. b. (boiled)	Yellow; cloudy	40	0	0	0
				1 h. a. b.	Watery; yellow	50	6	2	2
				1½ h. a. b.	Light; yellow	40	10	6	5
				2 h. a. b.	Light; yellow	40	8	4	4
6	Mr. T. T.	Gastric ulcer	HCl+; ac., 60	Oct. 27, 1917					
				½ h. a. b.	Cloudy	10	0	Tr.	Tr.
				1 h. a. b.	Clear	10	7	2	2
				1½ h. a. b.	Clear	15	7	5	6
				2 h. a. b.	Turbid	25	4	2	Tr.
7	Mrs. W. B.	Gastric ulcer	½ h. a. b., HCl+; ac., 40	Mar. 9, 1918					
				½ h. a. b.	4 c.c.; yellowish-green tinge; turbid	15	8	2	4
			1 h. a. b., HCl+; ac., 60	1 h. a. b.	1 c.c.; yellow; slightly tubid	20	8	3	3½
				1½ h. a. b.	½ c.c.; yellow; slightly turbid	25	7½	7	4
				2 h. a. b.	1 c.c.; straw yellow; slightly turbid	25	10	7	5
				GROUP III.					
8	Mrs. J. T. P.	Cholecystitis; gastric ulcer	HCl+; ac., 65	Feb. 10, 1918					
				Fasting	7½ c.c.; yellow; turbid	40	20	7	4½
				½ h. a. b.	7 c.c.; yellow; turbid	20	12	3	2
				1 h. a. b.	5½ c.c.; yellow; turbid	35	6	2½	4
				1½ h. a. b.	5 c.c.; reddish tinge; sediment	40	5½	1	4
				2 h. a. b.	8 c.c.; light yellow; sediment	40	15	1	5
9	Mr. C.	Duodenal ulcer	HCl+; ac., 70	Sept. 17, 1917					
				½ h. a. b.	6 c.c.; golden yellow	15	6	1½	1½
				1 h. a. b.	7 c.c.; golden yellow	20	6	3	4
				1½ h. a. b.	2 c.c.; golden yellow	25	5	1	2
				2 h. a. b.	4½ c.c.; golden dark	30	6	5	5

h. a. b. = hour(s) after bouillon.

TABLE OF CASES IN WHICH FRACTIONAL EXAMINATIONS OF THE DUODENAL CONTENTS WERE MADE—*continued.*

No.	Name.	Diagnosis.	Gastric contents.	Date and time.	Duodenal contents.					Remarks.
					Quantity and appearance.	Alkalinity.	Amylopsin.	Steapsin.	Trypsin.	
				GROUP III—Continued						
10	Mr. P. D.	Duodenal ulcer	HCl+; ac., 72	Sept. 30, 1918						
				½ h. a. b.	Pale green	17½	8	½	1	
				1 h. a. b.	Yellow, green	22½	9	1	1½	
				1½ h. a. b.	Green	10	6	½	1½	
11	Mrs. L. M.	Enteroptosis; hyperchlorhydria	HCl+; ac., 80	Mar. 17, 1918						
				Fasting	1 c.c.; green; turbid	20	8	4	5	
				1 h. a. b.	5 c.c.; greenish yellow; clear	30	7	3	3	
				1 h. a. b.	1 c.c.; yellow, tinge of green; clear	20	9	Tr.	5½	
				1½ h. a. b.	2 c.c.; yellow, tinge of green; clear	30	8	1	6	
				2 h. a. b.	2 c.c.; yellowish green; slightly turbid	25	8	2	6	
12	Mrs. E. W. G.	Gastric ulcer	HCl+; ac., 80	Nov. 21, 1917						
				½ h. a. b.	Turbid	0	0	0	0	
				1 h. a. b.	Turbid	10	5	1	0	
				1½ h. a. b.	Green; turbid	12½	6	1½	2	
				2 h. a. b.	Green; turbid	12½	5	1	1	
13	Mr. W. E.	Gastric ulcer; nephrolithiasis	HCl+; ac., 80	Sept. 27, 1917						
				½ h. a. b.	Colorless; clear	0	0	0	0	
				1 h. a. b.	Yellow; turbid	15	8	½	1	
				1½ h. a. b.	Green; turbid					
				2 h. a. b.	Green; turbid	10	10	½	1	
14	Mr. I. O.	Gastric ulcer	HCl+; ac., 90	Oct. 4, 1917						
				½ h. a. b.	Light yellow	2	3	1	1	
				1 h. a. b.	Light yellow	10	5	1½	1½	
				1½ h. g. b.	Green	15	6	1½	1	
				2 h. a. b.	Green	15	3	½	½	
15	Mr. M. S.	Gastric ulcer	HCl+; ac., 90	Jan. 18, 1918						
				½ h. a. b.	2 c.c. gold yellow	10	2½	1	3	
				1 h. a. b.	4 c.c. gold yellow; clear	20	5	2	2	
				1½ h. a. b.	3 c.c. gold yellow; clear	20	5	2	3	
				2 h. a. b.	2 c.c. gold yellow; clear	10	7	2	2	

				Sept. 19, 1918						
16	Mr. W. F. Mc.	Duodenal ulcer	HCl+; acidity, 90	½ h. a. b.	Yellow	20	4	1	5	
				1 h. a. b.	Colorless	25	3	1		
					Colorless	..	3½	½	2	
					Colorless	..	3			
				Feb. 28, 1918						
17	Mr. C. M. D.	Duodenal ulcer	HCl+; ac., 90	Fasting	½ c.c.; whitish; turbid	..	0	Tr.	Tr.	
				½ h. a. b.	1 c.c.; turbid: yellowish tinge	..	9	1½	2	
				1 h. a. b.	1 c.c.; slightly yellow; turbid	..	5	4	2½	
				1½ h. a. b.	3 c.c.; yellowish-green tinge; slightly turbid	20	8	4	5	
				2 h. a. b.	4 c.c.; yellowish green	30	11	1½	8	
				Feb. 9, 1918						
18	Mrs. H. M.[illegible]R.	Pyloric ulcer	HCl+; ac., 96	Fasting	4 c.c.; yellow; turbid	20	6½	5½	3	
				½ h. a. b.	5 c.c.; yellow; turbid	15	5½	2½	2½	
				1 h. a. b.	2 c.c.; yellow; turbid	20	9	6	3	
				1½ h. a. b.	1¾ c.c.; yellow; turbid	30	6½	2	4	
				2 h. a. b.	3½ c.c.; yellow; turbid	30	6½	2½	2	
				Group IV.						
				Mar. 12, 1918						
19	Mr. J. D.	Duodenal ulcer	HCl+; acidity 35	Fasting	6 c.c.; yellow; turbid	35	5	1	4	
				½ h. a. b.	4 c.c.; yellow; turbid; greenish tinge	30	10	2	4½	
				1 h. a. b.	6 c.c.; straw colored; very slightly turbid	35	9	2½	4	
				1½ h. a. b.	2 c.c.; yellow; very slightly turbid	30	6	1	2	
				2 h. a. b.	3 c.c.; yellow; very slightly turbid	30	7	1½	5	
				Feb. 23, 1918						
20	Mr. M. S.	Probable cholelithiasis; chronic gastric catarrh	HCl+; ac., 35	Fasting	6 c.c.; yellow, green; turbid	15	8	1½	Tr.	
				½ h. a. b.	6 c.c.; yellow, green; turbid	20	14	7	Tr.	
				1 h. a. b.	½ c.c.; straw yellow	..	10	4	4	Urobilinogen
				1½ h. a. b.	¼ c.c.; yellow; clear	..	6	1	1	not present.
				2 h. a. b.	½ c.c.; yellow	..	Tr.	Tr.	Tr.	

h. a. b. = hour(s) after bouillon.

TABLE OF CASES IN WHICH FRACTIONAL EXAMINATIONS OF THE DUODENAL CONTENTS WERE MADE—*continued.*

No.	Name.	Diagnosis.	Gastric contents.	Date and time.	Duodenal contents. Quantity and appearance.	Alkalinity.	Amylopsin.	Steapsin.	Trypsin.	Remarks.
				GROUP IV—Continued						
21	Dr. F. W. H.	Gastric catarrh	HCl?; ac., 20	Mar. 10, 1918						
				Fasting	15 c.c.; greenish; turbid	Ac.	0	0	0	Probably from the stomach.
				½ h. a. b.	10 c.c.; turbid; greenish tinge	Ac.	0	0	0	
				1 h. a. b.	6 c.c.; yellow; clear	20	8	Tr.	3	
				1½ h. a. b.	4 c.c.; yellow; clear	15	8	2	5	
				2 h. a. b.	6 c.c.; straw yellow; slightly turbid	10	6	1	3	
22	Mrs. W.	Cholelithiasis	.....	Mar. 23, 1918						
				Fasting	8 c.c.; golden yellow; very slight turbidity	10	11	3	5½	
				½ h. a. b.	8 c.c.; straw yellow; very slight turbidity	12	9	2	6	
				1 h. a. b.	10 c.c.; light yellow; turbid	12	8	3	6	
				1½ h. a. b.	6 c.c.; yellow; greenish tinge; clear	10	11	6	5	
				2 h. a. b.	7 c.c.; yellow; clear; greenish tinge	12	13	3	4	
23	Mrs. A. L. M.	Biliary obstruction and fistula	HCl +; ac., 40	Feb. 19, 1918						
				Fasting	1 c.c.; yellow; turbid	15	5	Tr.	Tr.	
				½ h. a. b.	2 c.c.; yellow; turbid	20	5	1½	1	
				1 h. a. b.	3 c.c.; yellow; turbid	20	7	1½	Tr.	Pancreatic rennet +.
				1½ h. a. b.	6 c.c.; clear	70	16	2		
				2 h. a. b.	7 c.c.; yellow; turbid	−10	Tr.	Tr.	Tr.	Free acid present.
				GROUP V.						
24	Mr. J. M. M.	Achylia gastrica; probable cholelithiasis	HCl, 0; neutral	Feb. 23, 1918						
				Fasting	2 c.c.; yellowish green; slight turbidity	20	6	Tr.	1	
				½ h. a. b.	6 c.c.; brownish yellow; very slightly turbid	30	17	8	10	

				1 h. a. b.	1½ c.c.; yellow; very slightly turbid	20	5	2	1½	Urobiligen not present.
				1½ h. a. b.	2 c.c.; yellow; slightly turbid	40	11	Tr.	2	
				2 h. a. b.	2 c.c.; very slightly turbid	30	8	1	1	
				Mar. 24, 1918						
25	Mr. S. E.	Chronic myelitis; achylia gastrica	HCl, 0; ac., 0	Fasting	10 c.c.; yellow; turbid	35	12	1	5	
				½ h. a. b.	10 c.c.; yellow; greenish tinge; turbid	30	14	1	5	
				1 h. a. b.	½ c.c.; straw yellow; slightly turbid	20	9	3	6	
				1½ h. a. b.	1 c.c.; golden yellow; clear	25	11	2	4	
				Mar. 8, 1918						
26	Mr. A. A. C.	Carcinoma of the stomach	HCl, 0; ac., 25	Fasting	4½ c.c.; milky; turbid	50	8	2	Tr.	
				½ h. a. b.	6 c.c.; yellow; turbid; sediment	55	11	6	4	
				1 h. a. b.	6 c.c.; light yellow; turbid; greenish sediment	60	10	5	6	
				1½ h. a. b.	5 c.c.; greenish yellow and sediment	60	10	3	4	
				2 h. a. b.	1 c.c.; greenish yellow and sediment	60	9	Tr.	3	
				GROUP VI.						
				Jan. 12, 1918						
27	Mr. O. H.	Diabetes mellitus; thrombo-angiitis obliterans	.....	½ h. a. b.	Yellow; clear	20	6	12	2	
				1 h. a. b.	Yellow; clear	24	10	5	3	
				1½ h. a. b.	Yellow; clear	10	12	5	6	
				2 h. a. b.	Yellow; clear	20	6	1	2	
				Mar. 15, 1918						
28	Mr. C.	Thrombo-angiitis obliterans	.....	Fasting	4 c.c.; yellow; turbid	15	6	1	2	
				½ h. a. b.	½ c.c.; yellow; turbid	..	7	0	3	
				1 h. a. b.	5 c.c.; greenish-yellow; turbid	20	14	5	3	
				1½ h. a. b.	1 c.c.; yellow; greenish; slight turbidity	30	8	2	4	
				2 h. a. b.	¼ c.c.; yellow	..	8	0	3	

h. a. b. = hour(s) after boullion.

TABLE OF CASES IN WHICH FRACTIONAL EXAMINATIONS OF THE DUODENAL CONTENTS WERE MADE—*continued.*

No.	Name.	Diagnosis.	Gastric contents.	Date and time.	Duodenal contents.					Remarks.
					Quantity and appearance.	Alkalinity.	Amylopsin.	Steapsin.	Trypsin.	
				GROUP IV—Continued						
				Mar. 10, 1918						
21	Dr. F. W. H.	Gastric catarrh	HCl?; ac., 20	Fasting	15 c.c.; greenish; turbid	Ac.	0	0	0	Probably from the stomach.
				½ h. a. b.	10 c.c.; turbid; greenish tinge	Ac.	0	0	0	
				1 h. a. b.	6 c.c.; yellow; clear	20	8	Tr.	3	
				1½ h. a. b.	4 c.c.; yellow; clear	15	8	2	5	
				2 h. a. b.	6 c.c.; straw yellow; slightly turbid	10	6	1	3	
				Mar. 23, 1918						
22	Mrs. W.	Cholelithiasis	.....	Fasting	8 c.c.; golden yellow; very slight turbidity	10	11	3	5½	
				½ h. a. b.	8 c.c.; straw yellow; very slight turbidity	12	9	2	6	
				1 h. a. b.	10 c.c.; light yellow; turbid	12	8	3	6	
				1½ h. a. b.	6 c.c.; yellow; greenish tinge; clear	10	11	6	5	
				2 h. a. b.	7 c.c.; yellow; clear; greenish tinge	12	13	3	4	
				Feb. 19, 1918						
23	Mrs. A. L. M.	Biliary obstruction and fistula	HCl+; ac., 40	Fasting	1 c.c.; yellow; turbid	15	5	Tr.	Tr.	
				½ h. a. b.	2 c.c.; yellow; turbid	20	5	1½	1	
				1 h. a. b.	3 c.c.; yellow; turbid	20	7	1½	Tr.	Pancreatic rennet +.
				1½ h. a. b.	6 c.c.; clear	70	16	2		
				2 h. a. b.	7 c.c.; yellow; turbid	−10	Tr.	Tr.	Tr.	Free acid present.
				GROUP V.						
				Feb. 23, 1918						
24	Mr. J. M. M.	Achylia gastrica; probable cholelithiasis	HCl, 0; neutral	Fasting	2 c.c.; yellowish green; slight turbidity	20	6	Tr.	1	
				½ h. a. b.	6 c.c.; brownish yellow; very slightly turbid	30	17	8	10	

				1 h. a. b.	1½ c.c.; yellow; very slightly turbid	20	5	2	1½	Urobiligen not present.
				1½ h. a. b.	2 c.c.; yellow; slightly turbid	40	11	Tr.	2	
				2 h. a. b.	2 c.c.; very slightly turbid	30	8	1	1	
				Mar. 24, 1918						
25	Mr. S. E.	Chronic myelitis; achylia gastrica	HCl, 0; ac., 0	Fasting	10 c.c.; yellow; turbid	35	12	1	5	
				½ h. a. b.	10 c.c.; yellow; greenish tinge; turbid	30	14	1	5	
				1 h. a. b.	½ c.c.; straw yellow; slightly turbid	20	9	3	6	
				1½ h. a. b.	1 c.c.; golden yellow; clear	25	11	2	4	
				Mar. 8, 1918						
26	Mr. A. A. C.	Carcinoma of the stomach	HCl, 0; ac., 25	Fasting	4½ c.c.; milky; turbid	50	8	2	Tr.	
				½ h. a. b.	6 c.c.; yellow; turbid; sediment	55	11	6	4	
				1 h. a. b.	6 c.c.; light yellow; turbid; greenish sediment	60	10	5	6	
				1½ h. a. b.	5 c.c.; greenish yellow and sediment	60	10	3	4	
				2 h. a. b.	1 c.c.; greenish yellow and sediment	60	9	Tr.	3	
				GROUP VI.						
				Jan. 12, 1918						
27	Mr. O. H.	Diabetes mellitus; thrombo-angiitis obliterans	.....	½ h. a. b.	Yellow; clear	20	6	12	2	
				1 h. a. b.	Yellow; clear	24	10	5	3	
				1½ h. a. b.	Yellow; clear	10	12	5	6	
				2 h. a. b.	Yellow; clear	20	6	1	2	
				Mar. 15, 1918						
28	Mr. C.	Thrombo-angiitis obliterans	.....	Fasting	4 c.c.; yellow; turbid	15	6	1	2	
				½ h. a. b.	½ c.c.; yellow; turbid	..	7	0	3	
				1 h. a. b.	5 c.c.; greenish-yellow; turbid	20	14	5	3	
				1½ h. a. b.	1 c.c.; yellow; greenish; slight turbidity	30	8	2	4	
				2 h. a. b.	½ c.c.; yellow	..	8	0	3	

h. a. b. = hour(s) after boullion.

TABLE OF CASES IN WHICH FRACTIONAL EXAMINATIONS OF THE DUODENAL CONTENTS WERE MADE—*continued.*

No.	Name.	Diagnosis.	Gastric contents.	Date and time.	Duodenal contents.					Remarks.
					Quantity and appearance.	Alkalinity.	Amylopsin	Steapsin	Trypsin.	
				GROUP VI—Continued						
29	Mr. S.	Thrombo-angiitis	.....	Jan. 31, 1918						
				Fasting	3 c.c.; watery; clear	..	0	0	0	
				1 h. a. b.	2 c.c.; yellowish	..	4	2	0	Rennet +.
				1 h. a. b.	½ c.c.; watery	N.	2	3	0	
				1½ h. a. b.	½ c.c.; watery	..	0	0	0	
30	Mr. B.	Thrombo-angiitis obliterans	.....	Jan. 29, 1918						
				½ h. a. b.	6 c.c.; yellow; slightly turbid	25	5	1½	0	
				1 h. a. b.	3 c.c.; yellow; green; turbid	20	10	2	4	
				1½ h. a. b.	8 c.c.; gold; yellow; turbid	25	5	1	2	
				2 h. a. b.	3 c.c.; yellowish green; turbid	15	6	1	2	
31	Mr. M.	Thrombo-angiitis obliterans	.....	Jan. 30, 1918						
				Fasting	½ c.c.; yellow; clear	Alk	0	½	½	
				½ h. a. b.	3 c.c.; yellow; clear	10	0	Tr.	Tr.	
				1 h. a. b.	3 c.c.; yellow; clear	10	0	0	0	
				1½ h. a. b.	8 c.c.; yellow; clear	20	0	½	½	
				2 h. a. b.	3 c.c.; yellow; clear	−5	0	½	½	
32	Mr. K.	Thrombo-angiitis obliterans	.....	Mar. 27, 1918						
				Fasting	8 c.c.; whitish; turbid; no bile	5	6	8	1	
				½ h. a. b.	10 c.c.; yellow; greenish; turbid	55	11	5	6	
				1 h. a. b.	3 c.c.; light yellow; turbid	15	9	1	4	
				1½ h. a. b.	5 c.c.; whitish; turbid; no bile	15	9	5	1	
				2 h. a. b.	7 c.c.; whitish; turbid; no bile	20	7	2	2	

h. a. b. = hour(s) after bouillon.

Group V comprises 3 cases of achylia, 2 benign and 1 complicated with cancer of the stomach. The alkalinity fluctuates between 20 and 40 in the 2 benign cases and between 50 and 60 in the cancer case. The strength of the ferments is highest between half an hour and one hour after the bouillon test meal.

Group VI. Six cases of thrombo-angiitis obliterans, one of which was complicated with diabetes mellitus, were likewise examined. They were all patients of Dr. Willy Meyer and were treated by duodenal instillation of Ringer's solution. I am greatly indebted to Dr. Willy Meyer for permission to examine their pancreatic function. The alkalinity was, on an average, somewhat lower than normal, fluctuating between 10 and 24; once it was 5 and once 55.

In 3 of the 6 cases the ferment activity was at times greatly reduced (Cohen, Scherr, Metloff), the steapsin ferment showing the greatest variations.

Epicrisis. The grouping of the table was arranged according to gastric secretion in order to see whether the latter has any bearing on the alkalinity curve. *A priori*, one would expect a lowered alkalinity in cases of hyperchlorhydria and conversely an increased alkalinity in cases of subacidity. This seems to be true in a certain measure, but not constantly so. It seems there are other factors besides gastric secretion which play a part in regulating the degree of alkalinity of the duodenal contents. Chief among these are the pancreatic and duodenal juices and the bile. Each one of these is liable to have its own peculiarities and show alterations in disease.

It appeared worth while to look at the different types of alkalinity curves found, regardless of gastric juice or any disease present.

The accompanying types of alkalinity curves can be easily discerned.

Type 1 (Chart I). Decrease of alkalinity during the first half hour after the bouillon, then a steady increase.

Type 2 (Chart III). Increase of alkalinity between one-half and one hour after the bouillon, then slight decrease. Chart II belongs to Type 1, Chart IV belongs to Type 2.

Type 3 (Chart V). Increase of alkalinity during first half-hour after the bouillon, then slight decrease up to one hour, then again increase to one and a half hours, thereupon again a decrease.

Type 4 (Chart VI). There is first a steady increase of alkalinity up to one and a half hours after the bouillon test meal then an abrupt descent of the curve, so that at two hours after the bouillon the contents are acid instead of alkaline.

Of the three ferments each shows its individual peculiarities; the strength of one ferment cannot be gauged by that of the other. It is possible to ascertain the strength of each ferment at the different periods after the test meal and express it in the form of a curve. But each one (A. S. T.) has its own curve.

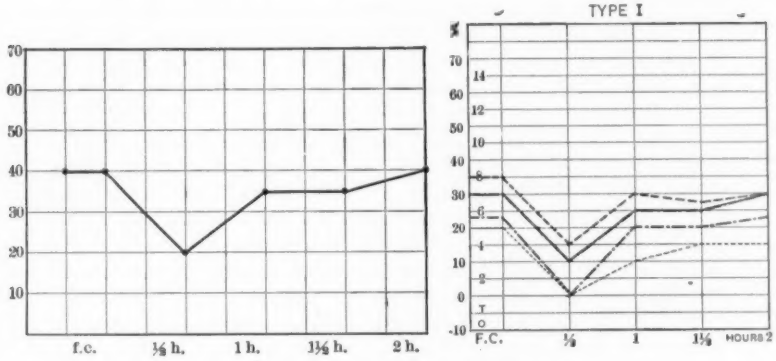

CHART I.—Case of Miss R. M. (No. 1). Alkalinity curve, Type I.

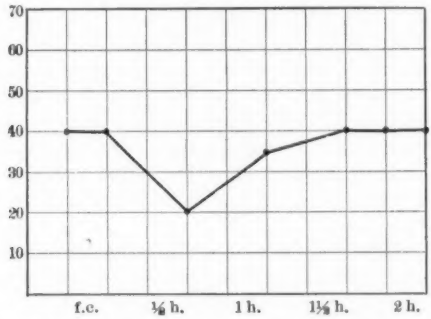

CHART II.—Case of Mrs. J. T. P. (No. 8). Alkalinity curve, Type I.

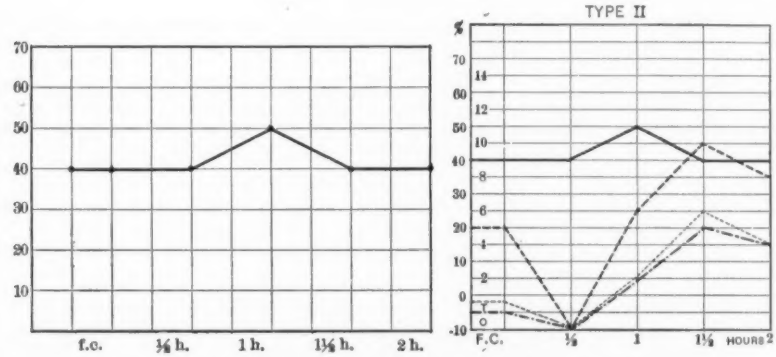

CHART III.—Case of Mr. J. M. W. (No. 5). Alkalinity curve, Type II.

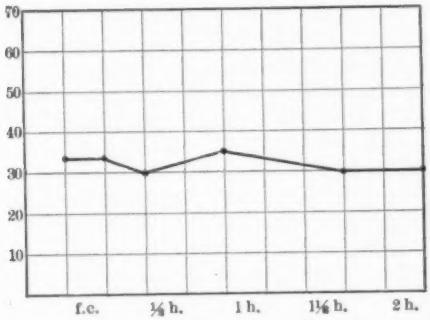

CHART IV.—Case of Mrs. J. D. (No. 19). Alkalinity curve, Type II.

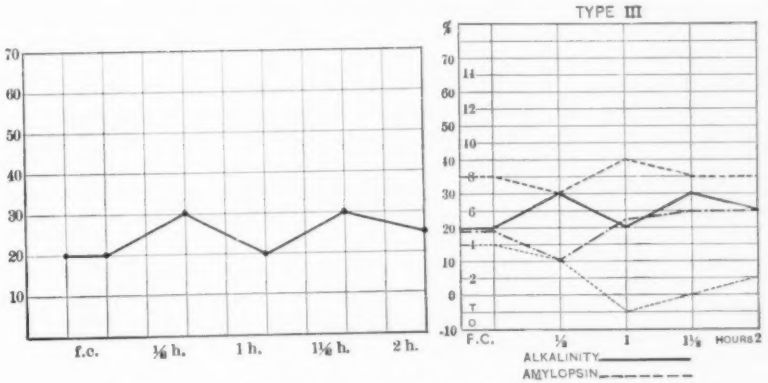

CHART V.—Case of Mrs. L. M. (No. 11). Alkalinity curve, Type III.

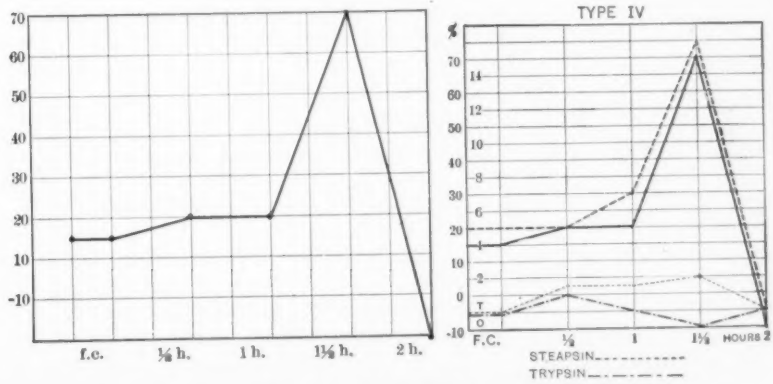

CHART VI.—Case of Mrs. A. L. M. (No. 23). Alkaainity curve, Type IV.

OBJECT OF DETERMINING THE ALKALINITY. The pancreatic secretions act best in an alkaline medium. The reversion of the acid gastric contents into an alkaline mixture is an important function of the duodenum and its neighboring organs.

It can be easily imagined that in pathological conditions this harmonious work in having the right medium will be lacking. We may then have conditions in which the degree of alkalinity is too high, or again too low, *i. e.*, diminished alkalinity or slight acidity.

AT WHAT TIME IS IT BEST TO EXAMINE THE DUODENAL CONTENTS? The fasting duodenal contents usually consist of some pancreatic secretion and bile, perhaps also duodenal secretion. The pancreatic juice this time is generally weak in ferment activity and gastric contents are not admixed therein.

The duodenal contents one to one and a half hours after the bouillon test meal represent a chyle embracing the pancreatic juice at the height of activity, bile, duodenal secretion and an admixture of gastric chyme.

To facilitate the diagnosis of liver and gall-bladder lesions it appears that the examinations in the fasting state will give the best results. For here the investigation of the bile, in as pure a state as we can obtain it, will form the main object.

In pancreatic affections, also in all conditions in which the principal part of the digestive act should be investigated, it will be best to examine the duodenal contents one to one and a half hours after the test meal. The height of the pancreatic activity found at this moment and also the reversion of the admixed gastric chyme from an acid to an alkaline medium, which is a very important function of the duodenum, make this time best suited for the above purposes.

CERTAIN ASPECTS OF THE CLINICAL VALUE OF THE ESTIMATION OF KIDNEY FUNCTION.[1]

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DURING this past year information upon several points in kidney function has accumulated in this clinic, which we believe to be of sufficient interest to warrant its publication. The material upon each of the questions presented is somewhat limited, but we hope that it will be of value to those engaged in similar work.

The necessity of determining kidney function by a combined

[1] This work was made possible by a grant from the James Cooper Fund of McGill Univerrity.

series of tests rather than by any single one is an important consideration. Many cases give decidedly deceptive results if a limited number of methods are employed, while too great a mass of information often obscures the essential points. This is well shown in the following case, which is illustrative of findings often encountered when studying nephritis:

Medical No. 28267. Male, aged thirty-four years, admitted to the Royal Victoria Hospital February 14, 1917. Diagnosis: early chronic diffuse nephritis. Complaint: headache. Physical examination was negative, but the urine showed 1 gram of albumin per liter, with a few cellular and granular casts. Blood-pressure: systolic, 135; diastolic, 90. The fundi were normal. Wassermann upon blood and upon cerebrospinal fluid was negative.

NEPHRITIC TEST-MEALS. On February 18 a nephritic test-meal, according to Mosenthal's technic, gave the following:

CHART I.

Time of day.	Urine, c.c.	Specific gravity.	Sodium chloride. Per cent.	Sodium chloride. Gm.	Nitrogen, Per cent.	Nitrogen, Gm.
8 to 10	43	1033				
10 to 12	54	1032				
12 to 2	68	1033				
2 to 4	83	1030				
4 to 6	56	1031				
6 to 8	70	1035				
Total day	374	....	0.983	3.63	2.097	7.75
Night, 8 to 8	309	1030	0.937	2.81	2.062	6.00
Total, 24 hours	683	....	....	6.44	.....	13.75
Intake	1760	....	.....	8.5	.....	13.4
Balance	+1077	....	.....	+2.06	.....	−0.35

The meal was repeated on February 26 and on March 8, the latter being done after two weeks of continuous rest and a restricted protein intake.

CHART II.—FEBRUARY 26, 1917.

Time of day.	Urine, c.c.	Specific gravity.	Sodium chloride. Per cent.	Sodium chloride. Gm.	Nitrogen, Per cent.	Nitrogen, Gm.
8 to 10	86	1023				
10 to 12	102	1024				
12 to 2	200	1014				
2 to 4	245	1014				
4 to 6	125	1022				
6 to 8	100	1025				
Total day	868	....	0.90	7.74	0.747	6.42
Night, 8 to 8	590	1022	1.21	7.14	0.834	4.92
Total, 24 hours	1458	....	.....	14.88	.....	11.34
Intake	1760	....	.....	8.5	.....	13.4
Balance	+302	....	.....	−6.38	.....	+2.06

CHART III.—MARCH 8, 1917.

Time of day.	Urine, c.c.	Specific gravity.	Sodium chloride. Per cent.	Sodium chloride. Gm.	Nitrogen, Per cent.	Nitrogen, Gm.
8 to 10	45	1032				
10 to 12	60	1032				
12 to 2	100	1026				
2 to 4	102	1027				
4 to 6	100	1022				
6 to 8	94	1022				
Total day	501	....	1.38	6.90	1.174	5.87
Night, 8 to 8	370	1027	1.22	4.51	1.262	4.67
Total, 24 hours	871	....	.....	11.41	.....	10.54
Intake	1760	....	.....	8.5	.....	13.4
Balance	+889	....	.....	−2.91	.....	+2.86

From a consideration of the above three meals one would think that on February 18 there was a moderate degree of passive congestion of the kidneys. On February 26 there was no evidence of passive congestion but the findings indicated a nephritis, as shown by a slightly increased night urine and an inability to properly concentrate nitrogen at night. On March 8 the results more closely resembled the findings on February 18. The above three test-meals alone present a very inaccurate idea of the true kidney state, but when they are considered in connection with further findings much light is thrown upon the condition. Three estimations of the rate of urea and chloride excretion follow:

Further, the phthalein on two occasions showed:

Date.	First hour.	Second hour.	Total.
February 23, 1917	82	15	97
March 1, 1917	68	27	95

Now the whole aspect of the case is changed, there being definite evidence of a hyperactive organ, as shown by an increased rate of urea excretion, a raised chloride threshold and an excessively high phthalein output, especially during the first hour. On March 12, after treatment, both the urea and chloride functions show marked improvement. The case would therefore be classified as a chronic diffuse nephritis. Lewis,[2] in his recent article, clearly showed the period of hyperactivity through which such kidneys passed before progressing into a degenerating nephritis, where the functions are grossly impaired. Such findings have been rather common with us and I think emphasize the importance of a thorough functional examination, especially for kidneys in the early stages of disease.

PRIMARY HYPERTENSION. In primary hypertension we have an obscure symptom-complex which some believe to be a disease entity while others consider it to be primarily a kidney condition. Lewis recently published results showing the abnormally high rates of urea excretion usually present, explaining them as due to a stage of

[2] Arch. Int. Med., 1915, xvi, 733.

CHART IV.

Date.	Weight. kilos.	Urine per 24 hours. c.c.	Urea.					Sodium chloride.					
			Gm. per liter of blood. Ur.	Gm. per liter of urine. C.	Gm. per 24 hours. D.	McLean's index.	Ambard. K.	Gm. per liter of urine. C.	Gm. per 24 hours. D.	Gm. per liter of plasma.			Threshold.
										Calculated.	Actual.	Difference.	
Feb. 23, 1917	59.3	1272	0.180	20.73	26.35	559	0.033	9.87	12.55	6.015	6.718	+0.703	6.323
Feb. 27, 1917	59.1	2448	0.120	9.66	23.64	774	0.028	6.30	15.42	6.013	6.406	+0.393	6.013
Mar. 12, 1917	59.2	888	0.225	21.96	19.48	272	0.048	9.80	8.70	5.950	6.281	+0.331	5.951

CHART V.

Medical No.	Date.	Weight. kilos.	Urine per 24 hours. c.c.	Urea.					Sodium chloride.					
				Gm. per liter of blood. Ur.	Gm. per liter of urine. C.	Gm. per 24 hours. D.	McLean's index.	Ambard. K.	Gm. per liter of urine. C.	Gm. per 24 hours. D.	Gm. per liter of plasma.			Threshold.
											Calculated.	Actual.	Difference.	
25077	Jan. 29, 1917 .	36.4	4128	0.150	2.44	10.05	172	0.057	3.70	15.26	6.067	6.625	+0.558	6.188
24839	Nov. 24, 1916 .	64.8	1512	0.330	15.73	23.73	120	0.070	6.35	9.60	5.918	6.312	+0.394	6.014
24827	Nov. 25, 1916 .	56.2	8232	0.270	1.80	14.81	44	0.121	1.30	10.70	5.846	6.500	+0.654	6.274

CHART VIII.

Serial No.	Medical No.	Date.	Weight. kilos.	Urine per 24 hours. c.c.	Urea.					Sodium chloride.					
					Gm. per liter of blood. Ur.	Gm. per liter of urine. C.	Gm. per 24 hours. D.	McLean's index.	Ambard. K.	Gm. per liter of urine. C.	Gm. per 24 hours. D.	Gm. per liter of plasma.			Threshold.
												Calculated.	Actual.	Difference.	
I	25224	Feb. 8, 1917	60.0	2280	0.330	6.81	15.53	55.5	0.110	1.68	3.81	5.759	5.75	−0.009	5.611
II	25337	Mar. 12, 1917	61.8	1944	0.352	17.77	34.53	171.0	0.061	18.15	35.28	6.376	6.125	−0.251	5.369
III	25496	May 8, 1917	60.8	2712	0.315	12.48	33.84	178.0	0.060	3.30	8.94	5.871	5.312	−0.559	5.061
IV	25598	May 22, 1917	53.4	2856	0.210	5.53	15.79	141.0	0.067	2.30	6.56	5.830	5.687	−0.143	5.477
V	24780	Nov. 11, 1916	59.1	2880	0.222	4.86	13.99	95.0	0.083	5.30	15.26	5.994	5.500	−0.494	5.126
		Nov. 21, 1916	58.1	2232	.....	.....	.....	.....	.....	6.30	14.06	6.000	5.906	−0.094	5.526
	25399	Mar. 14, 1917	60.0	696	0.345	14.55	10.12	48.5	0.115	3.80	2.64	5.762	6.375	+0.613	6.233
		Apr. 11, 1917	57.9	3312	.....	.....	.....	.....	.....	3.90	6.45	5.848	6.312	+0.464	6.084
VI	25266	Feb. 4, 1917	62.0	1632	0.225	19.11	30.96	387.0	0.041	10.00	16.32	6.066	6.062	−0.004	5.618
VII	25492	Apr. 11, 1917	72.4	3672	.....	.....	.....	.....	.....	5.3	19.44	6.004	5.812	−0.192	5.428
VIII	24895	Jan. 19, 1917	20.9	9408	.....	.....	.....	.....	.....	5.4	50.8	6.776	6.750	−0.026	5.594
IX	25410	Apr. 11, 1917	51.6	4752	.....	.....	.....	.....	.....	1.6	7.60	5.830	5.937	+0.107	5.725
		May 11, 1917	50.2	5040	0.315	5.98	30.16	139.0	0.068	3.8	19.15	6.039	5.937	−0.102	5.518
X	24632	Nov. 29, 1916	46.0	3264	.....	.....	.....	.....	.....	3.7	12.07	5.966	6.156	+0.190	5.810
XI	25410	Mar. 14, 1917	68.8	1272	0.315	14.02	17.83	88.0	0.085	3.3	4.19	5.782	6.062	+0.280	5.900
XII	25121	Feb. 15, 1917	56.1	4824	0.210	5.05	24.35	198.0	0.056	4.0	19.29	6.023	6.875	+0.852	6.472
XIII	25226	Feb. 15, 1917	85.5	1272	0.420	25.41	32.30	97.0	0.081	8.6	10.94	5.918	6.812	+0.894	6.514

CHART IX. MEDICAL NO. 24778.

Date.	Weight. kilos.	Urine per 24 hours. c.c.	Urea.					Sodium chloride.					
			Gm. per liter of blood. Ur	Gm. per liter of urine. C	Gm. per 24 hours. D.	McLean's index.	Ambard. K.	Gm. per liter of urine. C.	Gm. per 24 hours. D.	Gm. per liter of plasma.			Threshold.
										Calculated.	Actual.	Difference.	
Nov. 6, 1916	55.8	1440	0.330	6.3	9.07	33.5	.....	3.16	4.53	5.805	6.493	+0.688	6.308
Nov. 20, 1916	58.2	3888	0.288	3.61	14.04	50.0	0.113	4.37	16.99	5.976	6.312	+0.336	5.956
Dec. 2, 1916	56.8	1608	0.270	2.85	4.56	16.6	0.196	3.0	4.82	5.806	6.687	+0.881	6.501
Dec. 12, 1916	55.2	3935	0.390	4.6	18.09	41.0	0.125	3.04	11.95	5.918	6.812	+0.894	6.414

irritability or increased tissue metabolism. Such findings are also present in exophthalmic goitre and fever and may be expected whenever there is a raised basal metabolism. The following 3 cases of hypertention confirm the results of Lewis, also presenting data upon the chloride threshold:

The impaired rate of urea excretion in the third case may be explained by the fact that the prolonged hyperactivity has led to a state of true degenerative nephritis.

As an example of an advanced grade of degenerative nephritis that may develop secondary to prolonged hyperactivity due to hyperthyroidism the following case is instructive:

CHART VI.—MEDICAL NO. 24776, FEBRUARY 8, 1917.

NEPHRITIC TEST-MEAL.

Time of day.	Urine, c.c.	Specific gravity.	Sodium chloride. Per cent.	Sodium chloride. Gm.	Nitrogen, Per cent.	Nitrogen, Gm.
8 to 10	182	1012				
10 to 12	74	1016				
12 to 2	160	1010				
2 to 4	178	1012				
4 to 6	274	1013				
6 to 8	198	1012				
Total day	1066	....	0.675	7.15	0.278	2.94
Night, 8 to 8	740	1016	0.618	4.57	0.432	3.19
Total, 24 hours	1806	....	.....	11.72	.....	6.13
Intake	1940	....	.....	8.50	.....	13.4
Balance	−134	....	.....	−3.22	.. ..	+7.27

LOCAL CONGESTION OF KIDNEYS (ARTERIAL). While studying a series of cases of trinitrotoluol poisoning we obtained functional kidney results which simulate a chronic passive congestion, the congestion probably being of arterial origin, as Odland[3] has shown that trinitrotoluol acts mainly upon the smaller arterial walls, causing their degeneration, with a resultant perivascular edema. A test-meal in such a case follows:

CHART VII.—MEDICAL NO. 24671, NOVEMBER 22, 1916.

NEPHRITIC TEST-MEAL.

Time of day.	Urine, c.c.	Specific gravity.	Sodium chloride. Per cent.	Sodium chloride. Gm.	Nitrogen, Per cent.	Nitrogen, Gm.
8 to 10	95	1029				
10 to 12	48	1029				
12 to 2	60	1030				
2 to 4	55	1030				
4 to 6	38	1030				
6 to 8	65	1030				
Total day	361	....	0.43	1 55	1.71	6.19
Night, 8 to 8	260	1028	0.44	1.14	1.59	4.15
Total, 24 hours	621	....	.....	2.69	.....	10.34
Intake	1760	....	.....	8.5	.....	13.4
Balance	+1139	....	.....	+5.81	.....	+3.06

[3] Arch Int. Med., 1817, xix, 1.

THE CHLORIDE THRESHOLD IN DIABETES MELLITUS. It is generally stated that the level of the chloride threshold is lowered in diabetes mellitus. This point was determined in 13 cases. It would seem that the level of the threshold is often found to change at different times in the course of the disease. We do not understand upon what factors this varying threshold depends, as shown in Cases V and IX. Whether the raising of the threshold indicates a progressive nephritis we are not prepared to state.

Chart VIII represents the rate of urea and of chloride excretion in 13 cases of diabetes mellitus.

ACTION OF DIGITALIS UPON THE CHLORIDE THRESHOLD. Whether digitalis is of any therapeutic value in lowering the chloride threshold depends upon the type of case. In conditions of truly advanced nephritis, with edema and raised thresholds, there is a response to its administration, probably favoring, to a certain extent, the elimination of chlorides. But with the discontinuance of the drug the threshold promptly returned to its former if not a higher level. At best it is only a temporary measure. In cardiorenal disturbances, especially when the condition is mainly cardiac, with a markedly raised threshold, the response is prompt, undoubtedly relieving the cardiac strain by emptying the blood plasma of accumulated chlorides and secondarily of fluid. Its action in chronic diffuse nephritis is well shown in the following case:[4]

Admitted to the Royal Victoria Hospital November 4, 1916. Diagnosis: chronic diffuse nephritis. Digitalis started on November 8, 15 minims of tincture per day. On November 10, 30 minims per day; November 20, 45 minims per day. Discharged November 28.

In cardiorenal conditions the 3 cases presented in Chart X are typical. The first two represent findings in purely cardiac cases, while the third one (Medical No. 24849) is a mixed case, there being considerable evidence of nephritis, as shown by the impaired rate of urea excretion. The first case (Medical No. 25100) on February 26, 1917, had been receiving 45 minims of tincture of digitalis for four weeks. The drug was stopped on March 2, with a resulting rise in the level of the chloride threshold. On May 4 the case was readmitted (Medical No. 25711) and was put upon 30 minims of tincture of digitalis, which was continued until after the second estimation on May 25, 1917.

The second case (Medical No. 25030) had received 45 minims of tincture of digitalis per day for five days previous to the first estimation. The drug was discontinued on January 10, 1917. Readmitted February 22 (Medical No. 25308). He received 30 minims of the tincture every day during the period which the three estimations cover.

The third case (Medical No. 24849) received 30 minims of tincture of digitalis from December 3 to 9 inclusive.

[4] Scientific Reports, Royal Victoria Hospital Series B, No. 1, 203.

CHART X.

Medical No.	Date.	Weight. kilos.	Urine per 24 hours. c.c.	Urea.					Sodium chloride.					
				Gm. per liter of blood. Ur.	Gm. per liter of urine. C.	Gm. per 24 hours. D.	McLean's index.	Ambard. K.	Gm. per liter of urine. C.	Gm. per 24 hours. D.	Gm. per liter of plasma.			Threshold.
											Calculated.	Actual.	Difference.	
25100	Feb. 26, 1917	46.7	2400	0.240	8.16	19.64	188.0	0.058	6.0	14.40	6.043	5.437	−0.606	5.014
	Mar. 8, 1917	49.6	1488	0.225	12.34	18.36	229.0	0.053	10.8	16.07	6.120	5.937	−0.183	5.437
	Mar. 15, 1917	50.2	1968	0.270	9.58	18.84	143.0	0.067	3.3	6.48	5.855	5.750	−0.105	5.515
25711	May 9, 1917	55.6	768	0.435	23.76	18.24	76.0	0.092	0.43	0.33	5.629	5.250	−0.379	4.871
	May 25, 1917	50.15	1056	0.360	15.67	16.54	90.0	0.084	5.12	5.41	5.870	5.437	−0.433	5.187
25030	Jan. 8, 1917	58.6	2784	0.300	5.85	16.27	67.0	0.098	5.5	15.31	6.000	5.620	−0.380	5.240
	Jan. 15, 1917	55.1	912	0.331	20.82	18.73	126.0	0.071	13.3	12.13	6.055	6.062	+0.007	5.627
	Feb. 7, 1917	65.4	1488	0.450	11.55	17.18	39.4	0.127	0.81	1.20	5.682	6.000	+0.318	5.938
25308	Feb. 26, 1917	58.4	2160	0.210	8.04	17.36	171.0	0.061	9.3	20.08	6.126	6.062	−0.064	5.556
	Mar. 16, 1917	57.3	2400	0.180	6.69	16.05	200.0	0.056	8.9	21.36	6.132	6.125	−0.007	5.613
	Mar. 19, 1917	55.7	1248	0.255	12.07	15.04	130.0	0.070	10.8	13.47	6.054	5.875	−0.179	5.441
24849	Dec. 5, 1916	59.5	1824	.....	.....	.....	.....	.....	1.65	3.00	5.743	5.875	+0.132	5.752
	Dec. 11, 1916	61.0	1752	0.750	11.16	19.55	17.0	0.196	2.15	3.77	5.766	6.937	+1.171	6.791
	Dec. 18, 1916	57.5	1464	0.705	11.68	17.09	18.6	0.186	1.85	2.70	5.744	6.000	+0.256	5.876

CONCLUSIONS. 1. The nephritic test-meal to be of the greatest value must be considered in connection with other functional work, preferably the calculation of the rate of excretion of urea and of chlorides and the phthalein test.

2. In primary hypertension the metabolism of the kidney is raised, resulting in an increased rate of urea excretion and a raised chloride threshold.

3. The nephritic test-meal picture in congestion of the kidneys due to an arterial cause closely simulates that due to a venous one.

4. The level of the chloride threshold in diabetes mellitus is usually below the normal of 5.62 gm. per liter. Some cases show a marked tendency for the level of the threshold to become altered at different stages of their condition.

5. As a means of lowering the level of the chloride threshold, digitalis is prompt and efficient in its action, it being most useful when the disturbance is of a cardiac origin.

My thanks are due to Miss Jacobson for her careful work in carrying out a large number of these chemical estimations.

WAR MEDICINE

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OPEN PNEUMOTHORAX: ITS RELATION TO THE TREATMENT OF EMPYEMA.[1]

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INTRODUCTION. In the preliminary report of the Empyema Commission the opinion was given that in the type of cases of empyema which accompanied the prevailing streptococcus pneumonia, operation should not be undertaken early but should be deferred,

[1] This experimental work has been carried out at the Hunterian Laboratory, Johns Hopkins Medical School, through the courtesy of Dr. W. G. MacCallum, to whom we are indebted for many kindnesses.

in order to allow time for the pneumonia to subside and for the empyema to become more localized by the formation of adhesions. One of the principal considerations which led to this opinion was the question of the possible harm to the patient caused by the creation surgically of an open pneumothorax in the presence of an already existing state of severe asphyxia. Notwithstanding the apparently striking clinical confirmation of the soundness of this point of view, as shown by our remarkable reduction in the mortality of 4.3 per cent. as compared with the average mortality of 30.2 per cent. noted in the replies of the various camps to the Surgeon-General's questionnaire of February 21, 1918, it seemed desirable to submit to experimental test some of the considerations which theoretically had led the commission to the adoption of deferred operation. This seemed especially desirable, since there was a possibility that our low mortality might have been due in some measure to a decrease in virulence of the organism. Accordingly, work has been carried out along the following lines: (1) a study of the effects of open pneumothorax in normal and diseased chests, (2) the experimental production of a streptococcus pneumonia and empyema in dogs comparable with that in the human, (3) a study of the effect of early operation in dogs with experimentally produced streptococcus empyema. The limited amount of time available for these investigations prevented as complete a study of the problems as seemed desirable, but nevertheless certain facts have been established which seem to have an important bearing on the method of treating the condition.

PART I.—PNEUMOTHORAX.

Definition. Under normal conditions each pleural cavity is completely filled by its corresponding lung and the cavity of which one speaks is only a potential one. When air is present in a pleural cavity the condition of pneumothorax exists. Air may enter either from an opening through the thoracic wall or from a communication with the lung. If the opening remains patent so that air passes in and out freely the condition is known as an "open pneumothorax." If air is enclosed within a pleural cavity so that its exit is blocked a "closed pneumothorax" is produced. Another type of pneumothorax, commonly called "valve pneumothorax," occurs when air may enter freely but cannot pass out again. The latter type is found usually in connection with communications between the lung and the pleural cavity, especially in tuberculosis and in pulmonary abscess. It is the first type—namely, open pneumothorax—which is of primary interest in this discussion, for it is this condition which is produced by early operation and drainage in cases of empyema. If the pleural infection is not sharply walled off by adhesions the operation will create a pneumothorax, and the insertion of a drainage tube, by continuously allowing the free passage of air into and out of the chest, will maintain an open pneumothorax after the operation.

Importance of Negative Intrapleural Pressure in Maintaining Respiration. By far the most harmful effects, and perhaps the only harmful ones, of a pneumothorax are the changed pressure relationships within the thorax. Normally, each pleural cavity has a potential negative pressure, and it is owing to this negative pressure that respiration can go on. At each inspiration the thoracic cavity is enlarged. This enlargement and the accompanying tendency of the lungs to lag behind obviously makes the pressure still lower within the pleural cavities until after the lungs have been filled with air, expiration occurs and, with the diminution in size of the pleural cavity, the intrapleural pressure tends to approach the atmospheric pressure but does not actually reach that height unless the glottis is closed. These pressures, of course, even normally, are subject to wide variations, depending upon the amplitude of the respiratory movements. They have been measured repeatedly in various ways by numerous observers in human cadavers, in the living human and in animals. Donders,[2] who was apparently the first to measure them, considered the normal intrapleural tension in man at the end of quiet expiration to be −7.5 mm. Hg. and at the end of inspiration −9 mm. Hg. Aron[3] made determinations on a living normal man and found at the height of quiet inspiration an average reading of −4.64 mm. Hg. and at the height of quiet expiration −3.02 mm. Hg. For a more detailed discussion of these points reference may be made to the extensive works of Emerson,[4] Sauerbruch[5] and L. Mayer.[6] It is not within the province of this article to review the literature on pneumothorax exhaustively, since this has been well done by each of the three authors just mentioned. Instead, we shall be concerned here only with those literature references which deal particularly with the salient points of our problem—namely, the relative harmfulness of open pneumothorax.

Prevalent Conceptions of the Mechanics of Open Pneumothorax. In the light of our experiments the prevalent conceptions of open pneumothorax seem to be based on an incorrect understanding of the condition. Practically, without exception, they start from the apparently erroneous assumption that the mediastinal structures constitute an unyielding, almost rigid, partition between the two sides of the thoracic cavity. This assumption in turn has given rise to the idea that one lung is collapsed and that the other lung alone carries on respiration, although somewhat impeded, perhaps, if the opening be a large one, by the bulging of the mediastinum against

[2] Quoted by Heynsius, Arch. f. d. ges. Physiol., 1882, xxix, 267.

[3] Die Mechanik und Therapie des Pneumothorax, 1902, quoted by Emerson, p. 194.

[4] Pneumothorax, Johns Hopkins Hosp. Rep., 1903, xi, 1.

[5] Zur Pathologie des offenen Pneumothorax und die Grundlagen meines Verfahrens zu seiner Ausschaltung, Mitteil. a. d. Grenzgeb. d. Med. u. Chir., 1904, xiii, 399.

[6] Les Bases Physiologiques de la Chirurgie Pleuropulmonaire, Ann. d. l. Soc. Roy. d. Sciences Méd. et Nat. de Bruxelles, 1906, xv, 1.

it. Garré,[7] for instance, in a series of diagrams to represent the conditions in open pneumothorax, shows the mediastinum as a straight line, in cases in which the opening is small, with one lung collapsed and retracted and the other lung (on the unopened side) of normal size and apparently unaffected. In cases with a large opening he represents essentially the same condition except for a slight bulging of the mediastinum away from and toward the opening on inspiration and expiration respectively. Here, again, the lung on the affected side is shown as contracted into a small mass about the hilum, whereas the opposite lung appears to be relatively unaffected. L. Mayer, after reviewing the literature extensively, states the situation in regard to pressure relationships in open pneumothorax as follows: "On the healthy side the modifications due to the pneumothorax with a small opening ought to adjust themselves by a deviation of the mediastinal pleura, the two surfaces of which are no longer submitted to conditions of identical equilibrium; on inspiration the lowering of intrapulmonary pressure of −7 mm. Hg. not manifesting itself on the fistula side, the mediastinal pleura ought to become curved toward the healthy side and narrow the expansion of the other lung; the inverse should be produced at expiration. In reality these theoretical differences are minimal and are scarcely established by experimentation. If, on the contrary, the pleural opening is widely gaping the atmospheric air enters and goes out freely at each respiratory movement and the lung of this side will not be called upon at all to become distended. At each inspiration the pressure of the two sides of the mediastinal pleura will be different; on the healthy side, negative pressure of 7 mm. Hg., on the other side atmospheric pressure, with aspiration of the mediastinum toward the healthy side, toward which it ought to be markedly convex. In moderate and light expiration the pressure on the two sides remains equal; but if a forced or sudden expiration supervenes the pressure is raised in the normal lung while it remains constant on the incised side, giving a convexity of the mediastinum on the side of the pneumothorax." It is seen, therefore, in Mayer's resumé of the common conceptions regarding the pressure relationships in open pneumothorax that there are several assumptions ordinarily taken for granted: (1) that a marked inequality of pressure exists in the two pleural cavities after the establishment of a communication between one pleural cavity and the external air; (2) that this marked inequality of pressure results in the more or less complete collapse and retraction of the lung on the opened side while the other lung remains but slightly affected; (3) the mobility of the mediastinum is a relatively unimportant factor. These conceptions are so commonly accepted that one finds ingrained in all the literature of pneumothorax references to the "sound lung,"

[7] Garré's Diagrams are reproduced in L. Mayer's article (loc. cit.). The originals were inaccessible to us.

the "healthy lung," the "unaffected lung," etc., when what is meant is the lung in the unopened pleural cavity, as if it were little, or not all, affected by the opening in the opposite pleural cavity.

Prevalent Conceptions of Open Pneumothorax Seem to be Erroneous in Light of Our Experiments. In our experiments, on the contrary, we have found that normally the mediastinal structures are so mobile that they offer practically no resistance to pressure on either side. In the normal human (both adult and child) the resistance offered by the mediastinum, when one pleural cavity contains air at a known pressure equivalent to that of 10 cm. of water, corresponds to a pressure of only 1 cm. or less of water, which, of course, is practically negligible. For all practical purposes, therefore, from the standpoint of pressure relationships, the thorax may be considered as one cavity instead of two. Any change of pressure in one pleural cavity will affect also the other one almost equally. The common conceptions of collapsed lung on one side and "healthy" or "normal" lung on the other, in the condition of open pneumothorax in the otherwise normal chest, must be erroneous. Roughly speaking, also, the degree of asphyxia which will follow the creation of an open pneumothorax will depend upon (1) the relation of the amount of air entering through the pneumothorax opening to the amount of air permitted to pass down the air-inlet to the lungs, and (2) the ability of the individual to compensate by increasing either the rate or amplitude of his respiratory movements, or both. The dog's mediastinal structures have the same mobility as the human beings; therefore, experimental results obtained on the living dog are applicable to man. The importance of these considerations in regard to the surgical treatment of empyema will be shown later under "General Discussion."

Sehrwald,[8] as long ago as 1889, arrived at some of the same conclusions which we have drawn from our work. His conclusions, however, seem not to have been based on much experimental work; and, perhaps for that reason, they have not influenced opinion so much as their soundness entitled them to do. For example, he stated that the influence of a unilateral open pneumothorax on respiration depends not on the absolute diameter of the opening but on the relation between the size of this opening and the diameter of the air passage to the lungs. He concluded also that the mobility of the mediastinum was a very important consideration; if it were delicate and easily stretched it would be aspirated so strongly against the "sound" lung that it would hinder its expansion. He made the important statement, furthermore, that very young individuals and those who previously had had normal thoracic organs, because of the delicacy and elasticity of their mediastinum, stand an open pneumothorax with much more difficulty than patients in whom,

[8] Zum Atmungsmechanismus beim offenen Pneumothorax, Deutsch. med. Wchnschr., 1889, xiv.

because of a strong thickening, the mediastinum has been converted into a firm, unyielding membrane. It is to be noted, however, that even he also had the conception of a "sound lung" as opposed to a collapsed lung, and that he did not recognize that the pressures in the two pleural cavities are practically equal, with the result that both lungs are collapsed to the same extent.

PART II.—EXPERIMENTAL RESULTS.

Parallelism of Thoracic Pressure Relationships in Dog and Human. Experiments have been carried out on both animals and human cadavers. In order to determine whether results obtained on living animals could be considered as applicable to the human, it seemed especially desirable to ascertain, if possible, the comparative mobility of the dog's mediastinum with that of the human under the same pressure relationships, since the dog seemed to be in general the most suitable animal for a study of the living conditions. The experiments which show this comparison will be described first. Since the human experiments could be carried out only on cadavers the procedure chosen was to compare the relationships in the human cadavers with those in recently killed normal dogs and then to compare these results with those obtained by similar means in living dogs. In this manner it was found that the experimental results obtained on living dogs were directly applicable to the living human. The experiments were carried out as follows:

A metal cannula (diameter 4 mm.) was inserted into each pleural cavity (usually in the fifth interspace in about the anterior axillary line). Each cannula was attached by rubber tubing of the same size and kind to a tambour which, by means of an indicator, registered the pressure changes on a smoked drum. In one rubber tube was interposed a T-tube, which was connected in one direction with a water manometer and in the other with a rubber atomizer bulb. By means of the bulb, air was forced into the corresponding pleural cavity until the manometer registered 10 cm. pressure. Simultaneously with the rise of the indicator on the tambour of that side the other indicator also became elevated above its base line. Calibration of the reading of the second indicator showed the equivalent of a pressure of 9 or 9.5 cm. of water. In other words, when a known pressure, equivalent to 10 cm. of water, was established in one pleural cavity there was practically the same pressure in the opposite pleural cavity. This experiment has been carried out on five human cadavers, two of which were infants of four months and fourteen months respectively, one a child, aged fourteen years, and two adults. Duplicate determinations on the same cadaver sometimes showed a variation of 0.5 cm. in the reading of the opposite side, due probably to experimental error: that is, when the pressure of the inflated side was the equivalent of 10 cm. of water,

that of the opposite side registered sometimes only 9 cm. and at other times 9.5 cm. No difference was noted whether the right or left pleural cavity was inflated. These results were strictly comparable with those which were obtained on normal dogs which had been killed with ether. It should be stated, however, that cadavers which had been kept in the refrigerator for several hours showed a difference in pressure sometimes of as much as the equivalent of 3 cm. of water, but control dead dogs kept in the same refrigerator for the same length of time always showed the same variations. Since the objects sought in the experiments was really to determine the extent of mobility of the mediastinum, it was necessary to rule out the possibility of pressure being transferred to the opposite side by being distributed through the diaphragm of the inflated side to the abdomen and from there through the diaphragm of

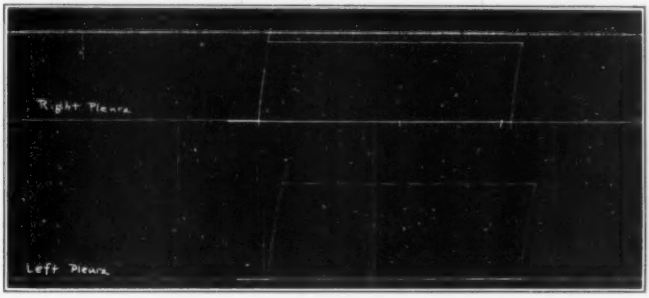


FIG. 1.—Tracing showing that when the left pleural cavity of a fresh adult human cadaver is inflated with air at a pressure of 10 cm. of water the right pleural cavity registers a pressure of 9 cm. The top line is a record of a pressure of 10 cm. made with the tambour attached to the right pleural cavity. Calibration showed that the actual pressure was 9 cm. of water.

the opposite side to that pleural cavity. In order to exclude such a possibility the abdomen was opened by a long median incision before inflation of the pleural cavity. By so doing the transfer of any extra pressure to the opposite pleural cavity by way of the abdomen was obviated. It is clear, therefore, that the distribution of the pressure from one pleural cavity to the other, under the conditions of the experiment, was due to the fact that the mediastinal structures were pushed over against the opposite lung. Furthermore, under a pressure equivalent to 10 cm. of water the rigidity of the mediastinal partition between the pleural cavities in both dogs and the human amounts only to the equivalent of from 0.5 to 1 cm. of water pressure (0.4 to 0.8 mm. of mercury), a value which obviously is practically negligible. (See Figs. 1, 2 and 3.)

It was suggested to us by Dr. Howell that perhaps a more conclusive demonstration of whether or not both lungs are nearly

equally compressed by raising the pressure in one pleural cavity could be made by comparing the relative densities of the two lungs when one pleural cavity was inflated with air at a known pressure. If the pressure relationships in both pleural cavities are affected about equally by altering the pressure in one then both lungs

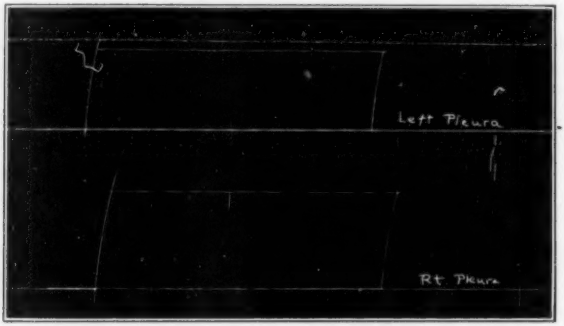


FIG. 2.—A similar tracing with the right pleural cavity inflated. Calibration showed that in this case also there was a difference in pressure of only 1 cm. of water (about 0.8 mm. of mercury).

should be about equally compressed and should show about equal relative densities.

In order to determine this point the following method was used: A normal dog was killed with ether or chloroform and into one pleural cavity air was injected until the pressure was equal to that of

FIG. 3.—Tracing made in the same way with a recently killed dog which shows that the dog is strictly comparable with the human, since here also the difference in pressure between the two pleural cavities amounted to only 1 cm. of water.

10 cm. of water. Through a low tracheotomy in the neck, plaster-of-Paris paste was then pushed down into each main bronchus in order to block its lumen. After allowing the plaster to "set" for a few minutes the lungs were then removed. In this way it was possible to remove the lungs so that they remained in the actual condition

in which they were before the chest was opened. The weight and volume of each lung was then determined, the latter by measuring the amount of water displaced. The plaster was then thoroughly removed from the bronchi and its weight and volume subtracted from that of the corresponding lung. In this manner the specific gravity of each lung was approximately determined, which indicated fairly closely the degree of compression of each lung. When dogs are killed with ether or chloroform the condition of the lungs is not uniform even when nothing else is done to them. One lobe may be well inflated while another is partly collapsed even on the same side. The specific gravity of the two lungs may vary considerably. In some cases the left and in other cases the right lung is the denser. But when the lungs are collapsed by inflating one pleural cavity these variations are not so apparent. The experimental results on five dogs are as follows:

	Density of lungs.	
	Left.	Right.
No. 1. Right pleural cavity inflated with air to a pressure equal to that of 10 cm. of water	.74	.74
No. 2. Left pleural cavity inflated	.73	.69
No. 3. Left pleural cavity inflated	.70	.72
No. 4. Control, not inflated	.52	.48
No. 5. Control, not inflated	.43	.51

The results thus demonstrate that the density of one lung practically equals that of the other when one pleural cavity is inflated with air—in other words, there is practically the same amount of compression of both lungs. These results, therefore, furnish additional evidence in favor of the principal conclusion to be drawn by our experimental work—namely, that when the intrathoracic pressure relationships are changed by the creation of an open pneumothorax both lungs are practically equally affected.

Experiments on the Living Dog. Experiments on the living dog not only demonstrate the fact that there is practically an equilibrium of pressure throughout the thorax, as already noted in the recently killed dog and in a fresh human cadaver, but they afforded an opportunity to investigate the extent to which an open pneumothorax produces dyspnea and asphyxia, the mechanism of the attempts at compensation, etc. The method used was in general the same in all the experiments. It consisted essentially in recording simultaneously on a smoked drum the pressure changes in each pleural cavity and in the trachea and the changes in the amplitude and rate of the respiratory movements. To record the variations in pleural pressure the same cannulas as already described above were inserted into the pleural cavities and connected with Marey tambours by means of rubber tubing. The changes of tracheal pressure were recorded in practically the same way by attaching a glass T-tracheal cannula to another tambour, and the variations in the rate and amplitude of the respiratory movements were noted by attaching a fourth tambour to a spring tambour, which was tied to the animal's chest.

When an opening was made into a pleural cavity, therefore, its effects could be at once determined by the movements of the various indicators on the revolving smoked drum. Most of the experiments were conducted under general anesthesia, either urethane or ether, but a few were performed with local cocain anesthesia. No important difference was observed between the changes in pleural pressure produced by the open pneumothorax when an animal was under the influence of general anesthesia and those produced when the opening in the pleural cavity was made under merely local anesthesia with cocain. The factor of general anesthesia, therefore, in most of the experiments can be considered as having no appreciable influence on the results. In the control experiments with cocain no attempt was made to record the tracheal pressure or the changes in the respiratory movements. In all thirty-eight dogs have been used for the work on pneumothorax. In addition, similar experiments have been carried out on three cats and two rabbits. No essential differences were observed regardless of the kind of animal used.

A marked difference in the character of the reaction by the animal occurs, depending upon whether a small or a large opening is made in a pleural cavity. By small or large opening is meant small or large in comparison with the air-inlet to the lungs. Normally the diameter of the air-inlet is the diameter of the opened glottis, but generally in our experiments it was the diameter of the tracheal cannula. A more detailed discussion of the important relationship which exists between the amount of air which enters the lungs and that which enters the pleural cavity will be given later in this article. The characteristic effects produced by a pleural opening smaller than the air-inlet to the lungs may be summarized thus: Immediately upon making the pleural opening there is an increase of pressure in both pleural cavities. Whereas, before making the opening both the inspiratory and expiratory pressures are entirely negative, immediately afterward the pressure rises so much that it is almost entirely positive; the indicators descend below the base line of atmospheric pressure only at about the end of the inspiratory effort. During this time there is noticeable a slight pause early in the course of the expiratory movement just before the pleural pressure reaches that of an atmosphere in its ascent from the negative phase. Simultaneously, also, the tracheal pressure changes in such a way that the indicator practically rests on the base line of atmospheric pressure instead of sweeping above and below the base line on expiration and inspiration respectively. This change is in accord with what is to be expected, since the tracheal pressure is a rough index of the amount of air passing down the trachea into the lungs, and since, obviously, with the pleural pressure almost entirely positive only a small amount of air can pass down the trachea into the lungs.

These changes are also coincidental with an effort on the part

of the respiratory mechanism to compensate by making a greater effort to get air into the lungs; accordingly there is a marked change in the respiratory movement. As a rule, this change is rather an increase in amplitude of respiratory movement than an increase in rate. If the amplitude is increased considerably the rate will of necessity be slower than before. If the pleural opening is small enough to allow compensation, the pleural pressures will gradually diminish so that negative pressure will be reëstablished and the tracheal pressure will rise simultaneously as the animal is enabled to get air into its lungs. The negative pressure, however, is never restored so completely as to reach the level at which it was before the opening was made, providing the opening remains in free communication with one pleural cavity. Instead of both the inspiratory and expiratory pleural pressures being negative, as in the normal state, the pressure at the height of expiration will be positive. The ability of the animal, therefore, to withstand an open pneumothorax is dependent upon his ability to compensate by increasing his respiratory effort. Obviously a strong, vigorous animal can compensate better than a weaker one. In our experience young adult dogs have uniformly withstood the harmful effects of an open pneumothorax better than old or weak and emaciated dogs.

It is a very striking fact that usually the restoration of negative pleural pressure can be instantly accomplished by simply closing the pleural opening, thus making a closed instead of an open pneumothorax. But here, again, the intrapleural pressure never becomes so low as it was before the opening was made. Presumably it would become normal as soon as the air contained in the pleural cavity was absorbed; but we have not tested this point. If the opening is made sufficiently large the animal will pass through a state of marked dyspnea and die of asphyxia within a few minutes, owing to his ability to compensate no matter how great his respiratory effort; for if the opening is so large that, despite his maximal respiratory efforts, he is unable to establish a negative pressure in the pleural cavity he will be unable to get air into his lungs, or if he is able to establish a slight negative pressure he may be able to get a little air into his lungs but not enough to maintain life. In this connection it is to be constantly remembered that, roughly speaking, an alteration of pressure in one pleural cavity is accompanied by an alteration of pressure to the same extent in the other pleural cavity. No such condition can be recognized as the collapse of the lung on the affected side and maintenance of respiration with only the other lung, as is the prevalent conception of open pneumothorax. Rather, both lungs must functionate about equally, since practically equal pressures are present in the two pleural cavities. In fact, if the opening into the pleural cavity be made in a favorable place for observation, and if it is not too large to prevent respiratory compensation, the lung on the affected side can

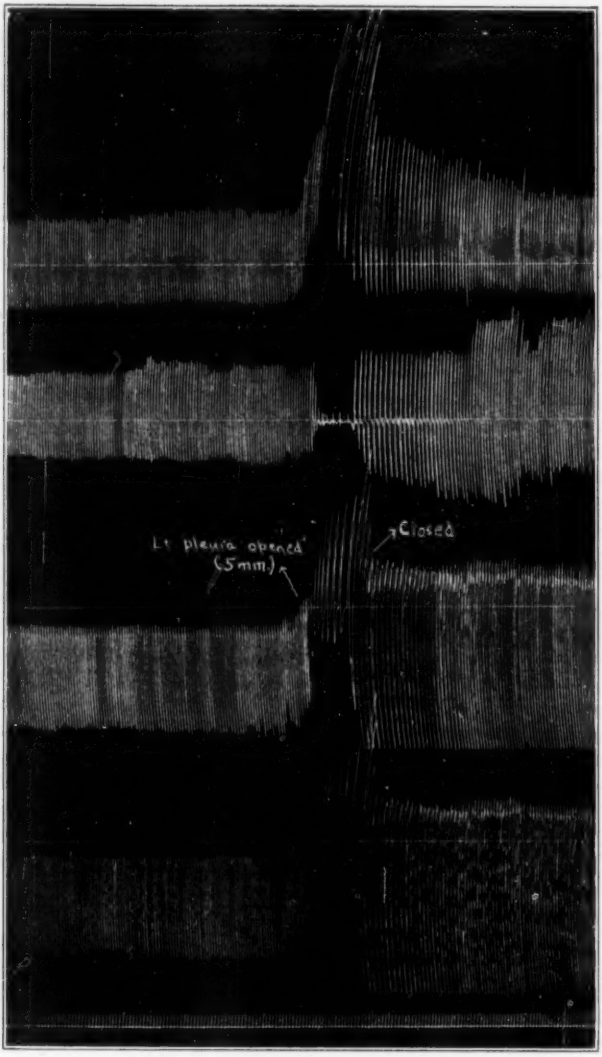
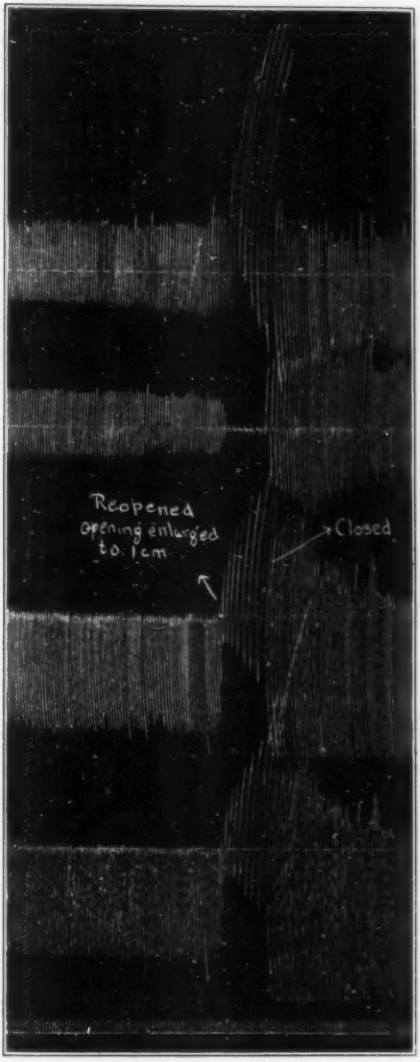


FIG. 4.—A tracing made on the living dog under ether anesthesia to show the nature of the reaction to an open pneumothorax with a moderate opening, as indicated in the changes in the respiratory movements, in the tracheal pressure and in the pressures in both pleural cavities. The upper tracings represents the respiratory movements, the next the tracheal pressure, the third the left pleural pressure and the fourth one the right pleural pressure. The lowest line indicates the time in seconds. The base lines were drawn at atmospheric pressure. The interval represents a duration of six minutes. Immediately after making the opening there is a simultaneous change of pressure in the pleural cavities from an entirely negative phase to one which



is mostly positive. The respirations are slowed but are increased in amplitude. Because the intrapleural pressure is largely positive, practically no air enters the trachea and the intratracheal pressure tends to be at equilibrium with atmospheric pressure. Immediately upon closure of the opening there is a simultaneous response in both pleural cavities, with restoration of negative pressure to a large extent, diminution of the amplitude of the respiratory movements and oscillations again of positive and negative intratracheal pressure, with inspiration and expiration. After an interval of six minutes during which time the air in the pleural cavities has probably been absorbed the intrapleural pressure has again become entirely negative.

be plainly seen to expand and contract with the inspiratory and expiratory efforts of the animal. Also, when a large opening is made, during the few minutes in which the animal remains alive the mediastinum can frequently be seen to flap from one side to the

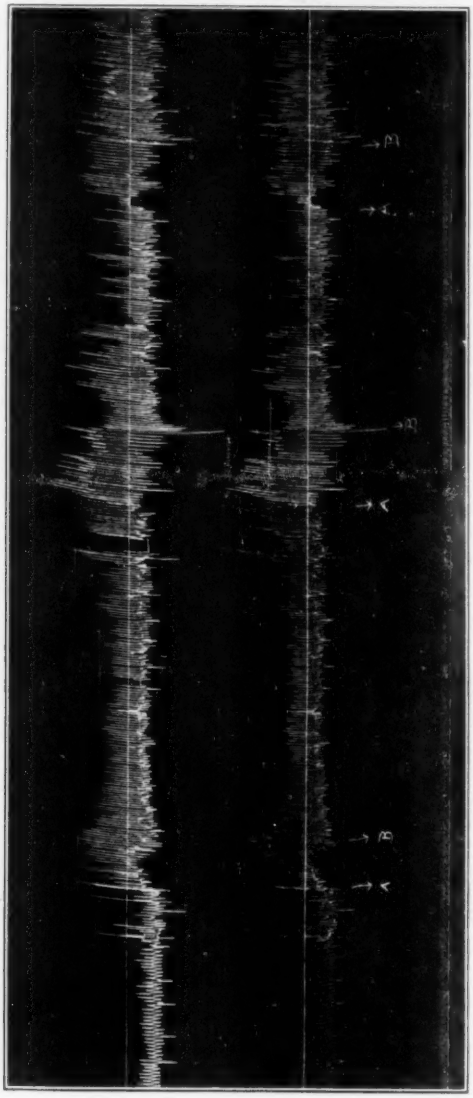


FIG. 5.—Tracing showing the simultaneous changes in intrapleural pressure in a dog when an opening of 5 mm. was made in the left pleural cavity with cocain anesthesia. The base lines again represent atmospheric pressure. The upper tracing is the right pleural pressure and the lower that of the left pleural cavity. At *A* and *B* in each case the chest was opened and closed respectively.

other with inspiratory and expiratory movements in much the same manner as a flapping sail caught in the breeze first on one side and then on the other. It sometimes happens that, with a severe expiratory effort, the mediastinal pleuræ are ruptured so that a double pneumothorax occurs. The various points about the changed pressure relationship may be best understood by reference to the accompanying reproduction of tracings. (See Figs. 4 and 5.)

Influence of Posture on Effects of Open Pneumothorax. Elsberg[9] has raised the point that an animal with an open pneumothorax may be favorably or unfavorably influenced by posture. He quotes Depage as saying that the prone posture is the best in thoracic surgery. As a result of experiments on dogs he concludes that the prone position enables the animal to withstand an open pneumothorax much better than the supine or a lateral position. In three experiments of our own on dogs we tested out the influence of a prone and supine position respectively and we were unable to note any beneficial influence exerted by the prone position. In fact, with the animal lying prone the difficulties of compensating for the opening in the pleura were increased owing to the necessity for the animal with each inspiratory effort to raise his weight from the table in order to enlarge his thorax with his inspiratory muscles. It is interesting, furthermore, in this connection that Emerson[10] after a most exhaustive review of the literature of pneumothorax states that "while, as a rule, the patient prefers to lie on the affected side there are two remarkable cases on record in which the knee-elbow position was chosen." Presumably the individual would choose whatever position would give him the most relief from his respiratory embarrassment, and the fact that there are only two cases on record in which preference was shown for a posture somewhat analogous to the prone would indicate that there is no decided relief gained usually from that posture. Probably the position which in a given case gives the greatest relief is somewhat dependent on the location of the opening and is brought about by the attempt on the part of the body to close the opening and thus to make a closed pneumothorax which, as will be shown later, causes the least respiratory embarrassment of all the types of pneumothorax if the amount of air enclosed is not too great. It seems possible that in the two exceptional cases quoted by Emerson the individuals had anterior openings.

Relation of Amount of Air Entering Thorax Opening to Amount of Air Entering Lungs. As has been mentioned earlier in this article the immediate influence of an open pneumothorax in producing respiratory difficulties depends upon the relation of the amount of air entering the pleural cavity to the amount of air entering the lungs.

[9] Pneumothorax and Posture, Jour. Exper. Med., 1909, xi, 444.
[10] Loc. cit., p. 390.

In the normal chest the action of the lungs, as a whole, proceeds practically as if no mediastinum were present, since the pressures in the two pleural cavities are always the same. If an opening is made into the chest cavity, part of the air which enters the chest during inspiration will pass in through the trachea and part will come through the chest opening. Only that part of the air which enters through the trachea is effective in carrying on respiration, and to prevent asphyxia the animal must increase either the rate or depth of respiration. If we assume that the rate of respiration remains constant and that all compensation is effected by increasing the depth of respiration, then the change of chest volume which occurs at each inspiration must be made greater by the amount of air which enters through the opening. That is, if the animal requires a volume of air (T), at each inspiration, and if a volume (B) enters through the opening, then the increase in chest volume at each inspiration must be $T + B$ after the opening is made.

If, however, the rate of inspiration is increased after the opening is made the volume of air required at each inspiration will be reduced. If the rate was R_1 before and R_2 after the opening was made then a volume of only

$$\frac{R_1}{R_2} T$$

will be required at each inspiration, and the required increase in volume of the chest to secure the same amount of air per minute will be—

$$\frac{R_1}{R_2} T + B$$

There is, however, a limit to the possible compensation. The change in the chest volume from maximum expiration to maximum inspiration is the same as the "vital capacity" V. The maximum possible compensation is reached when the increase in chest volume is V and when R_2 is the greatest possible rate comparable with this depth of respiration. Under these conditions it is evident that—

$$B = V - \frac{R_1}{R_2} T$$

represents the greatest volume of air that can enter through the thoracic opening if the animal is to survice even for a short time.

The ratio of the volume of air entering the chest through the thoracic opening to the volume entering the lung through the natural air passages would be equal to the ratios of their areas if it were not for two facts: (1) the natural air passages to the lungs have a considerable length which causes appreciable friction and a resistance to the entrance of air, and (2) the natural elasticity of the lungs

offers further resistance. On account of these two factors an opening in the chest wall of a somewhat smaller size than the narrowest part of the natural air passages will admit the same amount of air. If the area of this narrowest part, which is the glottis, is C, and if the resistance to the passage of air makes this opening equivalent to an opening of an area aC located in the thoracic wall (a being less than 1), then the entire ratio of the volume of air entering the chest through the thoracic opening to the volume entering the lung through the natural passages will be—

$$\frac{X}{aC}$$

X being the area of the thoracic opening. But from the equation above the maximum of this same ratio is—

$$\frac{B}{\frac{R_1}{R_2}T} = \frac{V - \frac{R_1}{R_2}T}{\frac{R_1}{R_2}T}$$

and substituting we have—

$$\frac{X}{aC} = \frac{V - \frac{R_1}{R_2}T}{\frac{R_1}{R_2}T}, \quad \text{or} \quad X = \frac{V - \frac{R_1}{R_2}T}{\frac{R_1}{R_2}T}aC$$

In a normal human chest during rest the maximum area (X) of a thoracic opening compatible with life for even a short time can be obtained by substituting numerical values in this expression. The average vital capacity V and the tidal air T are given by Howell[11] as 3700 c.c., and 500 c.c., respectively. The normal rate of respiration R_1 during complete rest is about 15 per minute and the maximum rate R_2 for the greatest possible depth of respiration is about 60 per minute.

$$\frac{R_1}{R_2}T$$

then equals 125 and

$$X = \frac{3700-125}{125}aC = 28.6\,aC$$

The area of the human glottis may be taken as 2.25 sq. cm., and the value of a may be assumed to be about 0.8 for the maximum rate and depth of respiration. Therefore, $aC = 1.8$ sq. cm. and $X = 51.5$ sq. cm. In other words, an opening about 5 x 10 cm. (2 x 4.1 inches) is the

[11] Text-book of Physiology, Philadelphia, 1911, p. 646.

largest for which compensation can theoretically be established in the human even for short periods if the mediastinum has normal mobility. Practically, the opening must be somewhat smaller, since the extra work performed by the muscles of the chest to establish compensation increases the amount of air required. The presence of toxemia, infection or any other cause which increases the level of metabolism will decrease the safety limits of the maximum size of

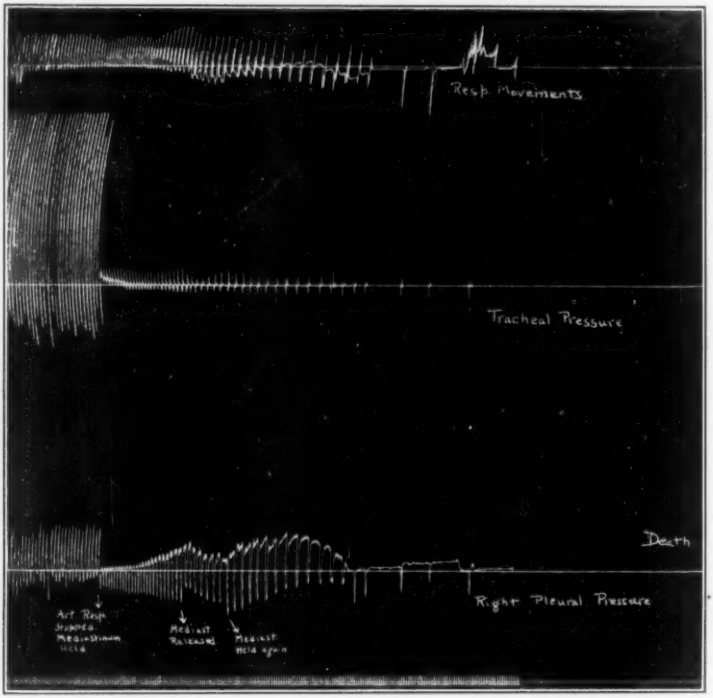


FIG. 6.—Showing slightly advantageous effect of holding of mediastinum in case of large opening into the left pleural cavity made by turning down a flap of pleura with six ribs while the dog was given artificial respiration by intratracheal insufflation.

the opening as will also any condition reducing the available breathing space of the lung. The use of general anesthesia will probably also act in the same way.

Effects of Immobilization of Mediastinum and Adhesions. Since the equalization of pressure in the thorax is dependent upon the mobility of the mediastinal structures, it would seem reasonable to suppose that any means of stabilizing the mediastinum would reduce the respiratory difficulties by confining the effects of the pneumo-

thorax to one pleural cavity. Old inflammation of the mediastinum with extensive induration will of itself result in a more rigid partition between the two pleural cavities. If, in addition to its being actually more rigid, the mediastinum is supported by strong adhesions the effect of an open pneumothorax on one side will be still less felt on the other. This is the condition which is often encountered in performing secondary operations of the type of Estlander, Schede, Delorme, etc., on old cases of empyema, and its presence probably accounts for the fact that in these operations the thorax can be opened widely with much less danger of respiratory embarrassment than is the case with the relatively normal mediastinum. These same factors also tend to make the deferred operation in acute empyema more safe than one performed too early. Experimentally, it can be shown that, furthermore, when the mediastinum is more or less fixed by pulling the lung well out of the pleural opening there is less pressure in the unopened pleural cavity than in the opened one. (See Fig. 6.) It is impossible, however, effectively to immobilize the normal mediastinum in that way because its extreme delicacy (especially in the anterior portion) allows it to be stretched and flapped about in spite of fixing it at one point by holding the root of the lung tight. It was hoped to demonstrate conclusively the influence which adhesions produced in various ways might have, but limitations of time have prevented it. The record of a single experiment, however, is presented. (See Fig. 7.) A few adhesions were produced between the lung and thoracic wall by the injection of 1 c.c. of turpentine. The record shows that during the intervals in which the left pleural cavity was open the right pleural pressure was distinctly less affected. On inspiration, for example, the pressure was twice as low in the right pleural cavity as in the left. This obviously enabled the dog to get more air into his lungs than he would have been able to do if the adhesions in the left pleural cavity had not to this extent prevented the aspiration of the mediastinum to the other side. Because of the elasticity of the lung tissue it is probable that extensive adhesions and those which involve the mediastinum itself are necessary in order to produce a more marked protective effect.

Closed Pneumothorax. In the description of the characteristic changes produced by making a free opening into the pleural cavity it was stated that the closure of the opening resulted in a sudden restoration of negative pleural pressure and a prompt relief from dyspnea. Obviously, after making the closure, air is still retained in the pleural cavity, so that the very striking difference in the phenomena observed must be due merely to the fact that an open pneumothorax has been converted into a closed one. Although air is absorbed from the pleural cavity, it disappears only slowly; and the sudden benefit noted by the closure of the opening cannot be attributed to the immediate disappearance of the air. Apparently

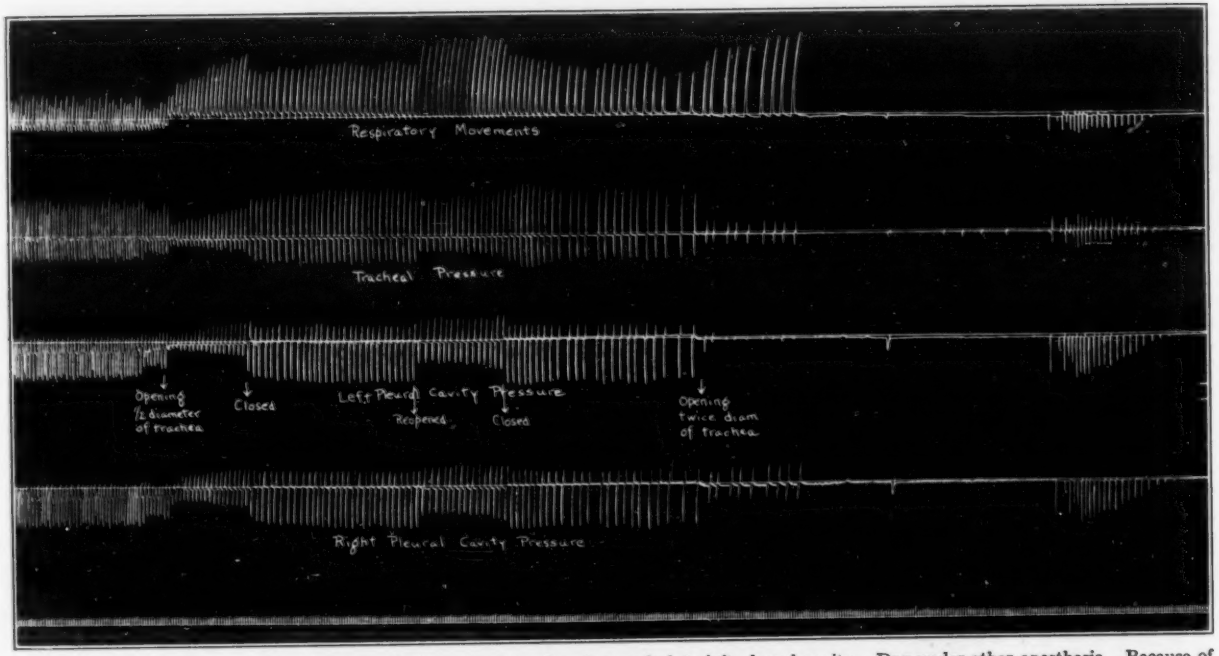


FIG. 7.—Adhesions between the left lung and thoracic wall. Opening made into left pleural cavity. Dog under ether anesthesia. Because of partial fixation of the mediastinum by the adhesions the right pleural cavity is less affected than the left. Respiration is maintained longer with the right lung than with the left, and there is more negative pressure on the right side than on the left when the left pleural cavity is opened.

the explanation of the relative harmlessness of a closed in comparison with an open pneumothorax lies rather in the fact that the ability to compensate for interference with the aëration of the lungs is limited. In a closed pneumothorax, no matter how much air is contained in a pleural cavity, no additional air can enter. It is necessary, therefore, only for the animal to increase his respiratory effort sufficiently to create enough negative pressure to allow him to take in the requisite amount of air to maintain aëration of his blood. Under conditions of rest this amount is equivalent only to the "tidal air," which in the human is about one-seventh of the total lung capacity. Accordingly, therefore, asphyxia should not occur until more than six-sevenths of the total lung capacity has been replaced by air in the pleural cavity, provided that the animal is at rest, that his ability to compensate by increasing his respiratory effort is good and that there is no extra abnormal demand for air such as might arise from toxemia. When an open pneumothorax is converted into a closed one, particularly if the closure is made at the end of expiration, the amount of air enclosed in the pleural cavity is very much less than six-sevenths of the total lung capacity, and naturally, therefore, there is comparatively little dyspnea. On the other hand in the case of an open pneumothorax there is an active competition for air going on between the trachea and the pleural opening. At each inspiration air not only enters the trachea but also enters the pleural cavity, and if the diameter of the pleural opening is the same as that of the trachea the same amount of air will enter the pleural cavity as enters the lungs and the animal will be compelled to increase his respiratory effort to get the "tidal air" in his lungs. If the opening is considerably larger than the trachea it will be still more difficult to get the required amount of air into the lungs, until when the pleural opening is of such size that more air than six-sevenths of the total lung capacity enters the pleural cavity with each inspiration the animal will no longer be able to obtain the requisite tidal air and he will die of asphyxia. This theoretical discussion is, of course, only an approximation and is not strictly accurate, since, as already shown in the paragraph dealing with the relationship of the diameter of the pleural opening to that of the air inlet to the lungs, it is necessary to consider the actual amount of air entering by each opening rather than merely the differences in diameter, a consideration which involves also the relative lengths of the pleural opening and the trachea with the resultant friction to the passage of the air. Observations, however, both clinical and experimental tend to confirm the truth of this explanation. For example, it is well known that an adult human can have as much as 2000 c.c. of fluid in his chest without producing alarming dyspnea so long as he remains at rest. Theoretically, he should be able to contain from 2500 to 3000 c.c. before developing a dangerous asphyxia if he remained quiet, and if it were not for the fact that his associated condition of toxemia and fever, uncompensated heart lesion, etc.,

demands a greater amount of oxygen than normal. Experimentally, we have injected into the pleural cavity of a dog of 8 kilos, through a small needle, as much as 1800 c.c. of air over an interval of twenty minutes without producing any marked asphyxia. Beyond that point, however, additional injections of only 50 c.c. at a time each had a very noticeable effect in increasing the dyspnea, and the animal died after about 2100 c.c. of air had been injected. The accompanying tracing illustrates the comparative harmlessness of a closed pneumothorax in which a moderate amount of air is present. Lest it should seem surprising that a dog of 8 kilos could withstand so large an amount of air as 1800 c.c. in his pleural cavity, it should be recalled that in proportion to the size of the rest of the body the dog has a much larger thorax than the human. (See Fig. 8.)

Effects of Open Pneumothorax other than Respiratory Disturbances. Besides its effects on respiration an open pneumothorax also induces other changes productive of harm to the body. These have been summarized by Sauerbruch[12] as heat loss, danger of infection and disturbances of the circulation. Sauerbruch himself has made some very important observations on the amont of heat loss. In unanesthetized rabbits in which he had established an open pneumothorax at a room temperature of from 20° to 22° C., the body temperature sometimes dropped as much as 3.5° C. within forty-five minutes. In dogs, also unanesthetized, within a half-hour he observed the body temperature fall 2° C. after making a pleural opening and rise again 1.6° C. within an hour after closing the opening. He also made the very striking observation that the heat loss in open pneumothorax is greater than in extensive laparotomy with eventration of the intestine for the same length of time. For example, a dog's temperature fell only 1° C. after having his intestine lying out of his abdomen for forty-five minutes, and a rabbit subjected to the same experiment showed a heat loss of only 1.3° C. after forty-five minutes.

The danger of infection is very great, since the ease with which organisms may be aspirated into the pleural cavity renders possible the infection of a relatively enormous amount of exposed surface. Naturally, also, a pleura already infected is exposed to secondary infection. That this readily occurs has been a frequent observation at Camp Lee in patients who had been operated on, and is a common experience to every surgeon. It explains, in many cases at least, the putrescent odor of the discharge so often present in old empyema cases. At Camp Lee we often found a great variety of bacteria after a pleural opening had been present for several days if means had not been taken to prevent the secondary infection, as by the use of Dakin's solution, etc. Ordinary aseptic dressing will usually not suffice to prevent the entrance of secondary invaders.

Marked disturbances in the general circulation have been noted by Sauerbruch as a result of the change of pressure relationships in the thorax, due to the pleural opening. He states that "in pneumo-

[12] Loc. cit.

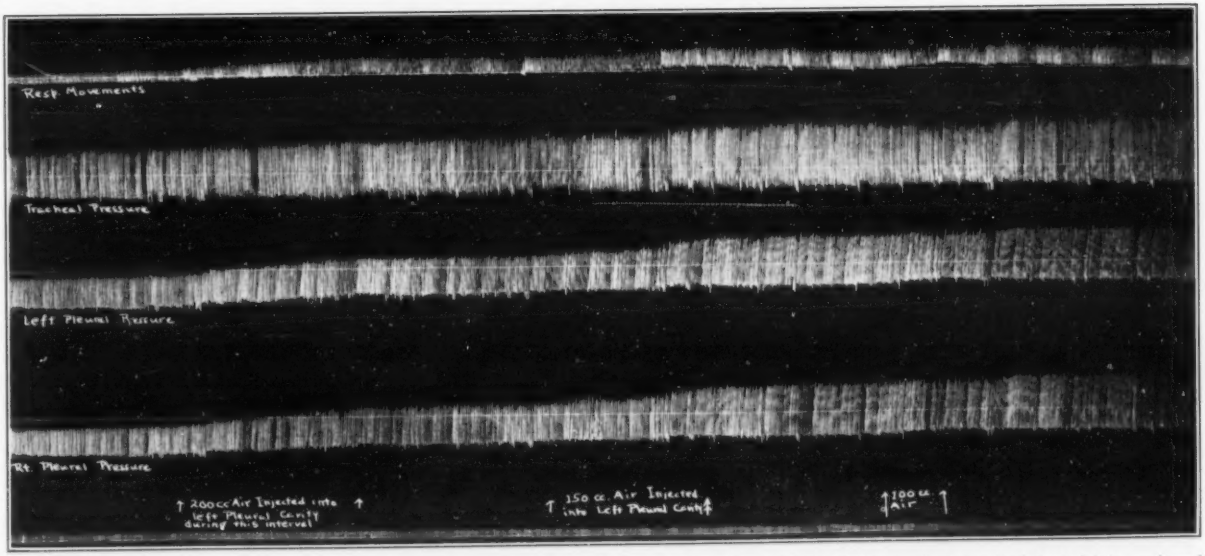

Resp. Movements
Tracheal Pressure
Left Pleural Pressure
Rt. Pleural Pressure
↑ 200 cc Air Injected into Left Pleural Cavity during this interval ↑
↑ 150 cc. Air Injected into Left Pleural Cavity ↑
↑ 100 cc. Air ↑

FIG. 8.—Closed pneumothorax in a 7-kilo dog under urethane anesthesia. It is to be noted that 450 c.c. of air can be injected into a pleural cavity without producing much distress, but again that the changes which result are strictly comparable in both pleural cavities.

thorax the aspiration of the heart fails; a stasis results in the venous system. Measurements of the venous pressure in the femoral vein give in fact an increase of the pressure." As a rule, there is not noteworthy change in the arterial pressure. When asphyxia occurs there is evident a rise in the carotid pressure, as might be expected. Sackur[13] claims to have found a marked diminution in the amount of oxygen in the blood, in some instances to only one-half.

PART III.—EXPERIMENTAL EMPYEMA.

In order to test the applicability of these ideas of open pneumothorax to the surgical treatment of empyema a series of twenty dogs in which empyema had been produced was used. After several preliminary failures to produce an empyema by the intrapleural injection of from 10 to 15 c.c. of pure broth cultures of a virulent strain of hemolytic streptococci given to us by Major R. A. Kinsella,[14] a successful result was finally accomplished by injecting into the pleural cavity of a 6-kilo dog 30 c.c. of a broth culture of the same strain which was highly virulent for mice. The dog died in about twelve hours after the injection, and at autopsy the left pleural cavity (the injected side) was found to contain about 200 c.c. of slightly blood-stained, serofibrinous fluid which contained myriads of streptococci and a few necrotic leukocytes. This exudate resembled in every respect the exudate obtained from the early human cases of streptococcus empyema at Camp Lee. Subsequently this exudate was used successfully in doses of from 1 to 5 c.c. for the production of empyema in the series of twenty dogs. In ten of the twenty dogs intercostal pleural drainage with cocain (0.5 per cent.) anesthesia was established from four to twenty-four hours after the operation. To the other ten dogs which served as controls nothing was done. The operations were all carried out under strictly aseptic precautions and sterile dressings were later applied. A stiff rubber drainage tube with a one-quarter inch (6 mm.) lumen was used for each dog and the tube was stitched to the skin in order to hold it in place. The point selected for the drainage in each case was the sixth interspace in the anterior axillary line, since this seemed to be the most dependent portion of the thorax with the dog in the natural position. Sixteen of the dogs each received 2 c.c. of the exudate, two each received 3 c.c. and two each received 1 c.c. All the injections were made into the left pleural cavity. The dogs were paired as carefully as possible according to weights, so that each dog operated upon had a control which was not only of approximately the same weight but which also had been injected with the same amount of pleural exudate. In general, out of each pair, the dog which seemed the stronger and the better operative risk was selected for the oper-

[13] Weiteres z. Lehre von Pneumothorax, Arch. f. path. Anat. u. Physiol., 1897, cl, 151.

[14] The particular strain used was the one which had been obtained at autopsy from the only fatal case of our series at Camp Lee. The patient had not only an empyema but also suppurative pericarditis and multiple small lung abscesses.

ation in order to give the operation every possible chance, since many of the dogs were poorly nourished and were victims of mange. In spite of all this, however, of the ten operated dogs all but one died (a mortality of 90 per cent.), and of the unoperated dogs only seven died (a mortality of 70 per cent.). Of the series of unoperated dogs also one fatality was in a dog which on the fourth day, while apparently well, was badly injured in a fight with another dog and received extensive lacerations in the neck, the back and the hind legs. Death occurred two days later and at autopsy the pleural cavity contained no exudate and appeared normal. It seems probable that it would not have died if it had not been for the wounds received in the fight.

It was a striking fact that of every pair of dogs which died the one which had been drained died from one to two days before its control with two exceptions, in which both the operated and the control dogs died at about the same time. It never happened that the unoperated dog of a pair died before the operated one. The only dog of the operated series which survived pulled its dressings off and pulled out the tube on the next day after the operation. When seen shortly afterward (within three hours after the dressings had been pulled off) the pleural opening had already closed so that the dog no longer had an open pneumothorax. This was the only dog which disturbed his dressings. As a rule, death occurred in the operated dogs from forty-eight to seventy-two hours after the operation, and in the control series from the fourth to the fifth day. Of one pair, each of which had been injected with 2 c.c. of the pleural exudate, both the control and the operated dog died after about twenty-four hours following the injection. The operated dog in this case had been drained four hours after receiving the injection. The operated dogs, as a rule, not only died more quickly than their controls but they all seemed much sicker than the unoperated dogs from the time that the pleural opening was made. They would lie quietly curled up, refusing food and resenting disturbance. The unoperated dogs were much more active. Immediately after operation each dog was placed in a cage by himself, was furnished with an abundance of water and food and the cage was kept clean. In almost every instance the dressings were changed daily, dry sterile dressings being substituted for the soiled ones, with rigid aseptic precautions, even to the extent of our wearing sterile gowns and sterile rubber gloves during the procedure. Each of the operated dogs had a profuse drainage of a thin serofibrinous discharge, sometimes slightly blood-stained, which microscopically showed innumerable streptococci and only a few leukocytes which were usually necrotic.

Each dog that died was examined at autopsy within a few hours after death. All of the operated dogs had been drained well, as shown by the absence of appreciable amounts of exudate in the pleural cavity. In practically every instance there was an extensive deposit of fibrin on the pleura, and there were many recent adhesions.

In general there were more adhesions in the dogs that had been drained than in the controls. Two dogs showed in addition to a left pleuritis involvement of the pericardium and the other pleura also. It was interesting that the pericardial fluid contained a noticeably smaller amount of organisms than the left pleural cavity and that the right pleural exudate contained even fewer. In other words, it appeared as if the infection had passed right through the pericardium and mediastinum from the inoculated left side. Of these two dogs, one had been drained and the other had not been. Three of the dogs that had been operated upon showed at autopsy pockets of pus behind the upper part of the sternum which resembled very much those which had been described frequently in the human cases. This condition has never been observed in any of the dogs which were not drained.

The fact that in this series there was a slightly higher mortality in the dogs that had had early drainage than in a control series of the same number which received no treatment of any kind seems to indicate very strongly that under the conditions of the experiment, early drainage at least is of no benefit to the animal, and if anything it is rather a source of harm. Presumably the harm is produced by the open pneumothorax, with the train of resulting effects which have been discussed earlier in this article. Any comparison, furthermore, with the condition of streptococcus empyema in man must carry with it the important consideration that theoretically this experimental empyema in dogs does not begin to contra-indicate the early establishment of an open pneumothorax to the same extent as the human condition for the reason that the dogs do not have the associated pneumonia which seems to have been universally present in the human cases and which necessarily lowers the threshold of safety for the establishment of an open pneumothorax. It was hoped to test out early aspiration with later operation on another series, but time was not available for the experiment.

PART IV.—EXPERIMENTAL PNEUMONIA.

Attempts were made to produce in dogs the typical pneumonia and empyema of the human cases. It was felt that success in the experimental production of the condition would not only allow a better opportunity to determine by experiment the best treatment of the condition, but that also an opportunity would be presented of perhaps studying the pathology in all of its various stages with particular reference to the factors underlying the occurrence of empyema. Here, again, unfortunately, it has been impossible to carry this part of the work to a conclusion because of lack of time. We have, however, been able in three out of six dogs to reproduce a condition experimentally which seems to be in every way identical with the pathological picture of the human pneumonia and empyema which has been so well described by Dr. W. G. MacCallum. The

method used was tracheal insufflation of pleural exudate from other dogs into a dog deeply anesthetized with ether. The amount of pleural exudate used has varied from 2.5 to 5 cm. One of the dogs in which a successful result was obtained also was moderately ill with distemper at the time the insufflation was made. A brief summary of one of the experiments with a gross description of the viscera of the dog as noted at autopsy is as follows:

An 8.5-kilo dog on August 28 was given 2 c.c. of pleural exudate by method just described above. On August 31 the dog died. There was a very extensive pneumonia of both lower lobes with scattered areas of consolidation in the other lobes. Bilateral empyema (200 c.c. thin, slightly purulent fluid in left pleural cavity and 100 c.c. in right pleural cavity) was found, as well as suppurative pericarditis (about 50 c.c. of exudate in the pericardial sac similar to the pleural exudate) with extensive deposition of fibrin on the pericardium. Extensive fibrinous adhesions were present in both pleural cavities with massive fibrinous deposits on the posterior surfaces of both lower lobes. Each lower lobe also showed posteriorly a necrotic patch about 1 cm. in diameter which was found to allow air to escape when attempts were made to inflate the lungs, according to MacCallum's method. It seemed in fact that on the right side there was a pneumothorax in addition to the empyema, as air apparently escaped from that side when it was opened. We were not sure, however, of this point. The tracheobronchial glands were much enlarged and there was a moderate tracheitis. The other organs showed no important changes. The lungs were not cut but the thoracic viscera were placed *in toto* in Kaiserling solution. A description of the appearance of the cut surface of the lungs will be included in the report on the microscopic examination by Dr. MacCallum.[15]

[15] Incision into the several lobes on each side reveals areas of reddish-gray consolidation most extensive in the lower lobes. There is on each side in the central portion of the area in the lower lobe a ragged cavity filled with fluid and necrotic material and extending to the pleura, which is torn so that the abscess cavity appears in both cases to have communicated with the pleura. Other smaller areas appear opaque and necrotic, but are not liquefied. Microscopically it is found that the pleura is thickened and covered with a fibrinous exudate. No broad lymphatics are traceable into the substance of the lung. The bronchi are filled with leukocytes, among which are very numerous streptococci. Their walls are not markedly altered, although the epithelium is frequently desquamated. No conspicuous or thrombosed lymphatics are seen in their walls nor in the walls of the bloodvessels. The alveoli are filled with an exudate of polymorphonuclear leukocytes, with some red corpuscles and great numbers of streptococci. Their walls are not infiltrated or thickened. Great areas in the midst of such consolidated tissue have become necrotic *en masse* and are surrounded by a zone of closely packed leukocytes. These areas, rich in streptococci, are sometimes intact, but the larger ones show a complete disintegration of the structure of the necrotic lung and of the enclosed exudate, and the softened, partly liquefied debris is seen to have retracted from the living tissue, which remains as a densely infiltrated wall. The consolidation has little in common with the interstitial bronchopneumonia observed in the recent epidemic, but is almost precisely like the condition also observed then which was referred to as lobular pneumonia. In that condition large numbers of streptococci invaded the lungs, causing a widespread intra-alveolar exudate, with hemorrhage and subsequent extensive necrosis of the infected tissue. The sections from the second dog repeat this picture so precisely that they need not be described.—W. G. M.

PART V.—GENERAL DISCUSSION.

Application of Experimental Results to Problem of Treatment of Empyema. In the light of all these observations it would seem definitely established that an operation for empyema performed too early in the course of the disease is accompanied by such very grave danger that in our opinion the risk of harm by the operation outweighs any advantages which it may have. These observations apply particularly to the type of empyema due to the hemolytic streptococcus prevalent in the epidemic last winter, but apparently they would apply equally well to any type of empyema. The principal determining factors to be considered in deciding whether the time is too early for operative interference are the relative immobility of the mediastinum, the presence of active severe pneumonia and the amount of asphyxia present. Practically it may be stated that, in general, the safest time to operate is when the exudate has become frank pus instead of being merely serofibrinous, for the following reasons: (1) There is less danger of creating an open pneumothorax because, in our experience, there is likely to be a circumscribed abscess shut off by adhesions from any communication with the free pleural cavity so that during the operation the pleural cavity, properly speaking, is not entered. (2) Even if an open pneumothorax is created the patient is in much better condition to withstand its harmful effects, because (*a*) the subsidence of the active pneumonia has the effect of making the area of the air-inlet to the lungs larger than when many of the bronchioles and much of the lung parenchyma are blocked by the pneumonic process, so that the pleural opening is incapable of producing the same amount of harm, (*b*) the presence of adhesions and the inflammatory thickening and induration of the mediastinum tend to make it less mobile, (*c*) the patient's need of oxygen is less because of a more nearly normal metabolism, (*d*) the respiratory compensation is more efficient since, owing to a diminished toxemia, the respiratory muscles will not become so easily fatigued. (3) The patient is in better condition to withstand whatever shock there is connected with even so slight an operation as pleural drainage. (4) There is probably less risk of creating a septicemia from absorption of organisms from the fresh operation wound, an occurrence which seemed to have happened a few times at Camp Lee by the finding of positive blood cultures a few hours after operation in cases which previously had shown negative blood cultures, the operation having been done very early in the disease.[16]

On the other hand the only advantage to be gained from an early operation is drainage which theoretically accomplishes the removal of both toxic material and living organisms and in addition relieves

[16] For our usual procedure in deciding when to operate upon cases of streptococcus empyema at Camp Lee, see "Preliminary Report of Empyema Commission," Review of War Medicine and Surgery, Office of the Surgeon-General, Washington, 1918, i, No. 6, also Jour. Am. Med. Assn., lxxi, 1918, 366 and 443.

mechanical embarrassment to respiration caused by the presence of a large amount of fluid. Practically, however, the mechanical embarrassment to respiration is almost sure to be aggravated instead of improved because of the creation of an open pneumothorax; and, moreover, the fluid can be withdrawn by aspiration as often as it accumulates in any considerable amount, a procedure which, of course, also removes some of the toxic material and living organisms. The apparently theoretically ideal method of continuous drainage under negative pressure involves the necessity of a special attendant to prevent a delirious patient from interfering with the apparatus and thus running the risk of creating an open pneumothorax. It should not be forgotten also that in many of these streptococcus cases operation will be unnecessary. Of our cases at Camp Lee, 13 per cent. recovered merely with aspiration.

If, in spite of consideration of all the relative dangers of an early operation, it should be decided nevertheless to establish drainage in a certain case, it seems apparent that only a small opening should be made during the stage of active pneumonia. Resection of ribs and the creation of large openings in the pleura should be reserved if necessary, until later, after adhesions and induration have changed the mediastinum into a relatively immobile partition.

In considering the mathematical expression given in a previous section it will be seen that any condition which increases the values of

$$\frac{R_1}{R_2}\,T$$

or which decreases the value of V or of aC will decrease the size of the maximum opening compatible with life. Thus any obstruction of the natural air passages, any interference with maximum contraction or expansion of the chest or any condition which increases the demand for air will tend to decrease the limit of safety in the size of the opening. In the early stages of a streptococcus pneumonia several such factors are present. There is great obstruction of the air passages, and the vital capacity is reduced by the consolidation of the lung and by the exhausted condition of the muscles of respiration. The amount of air required is greatly increased since the general metabolism is nearly doubled. All these factors tend to reduce the size of the thoracic opening for which compensation can be made by the patient. In fact, some cases have already so much interference with respiration that they are partially asphyxiated and a thoracic opening of any appreciable size must inevitably cause death.

On the other hand a patient who has recovered from the pneumonia and presents only an empyema is in a much more favorable condition to stand an open pneumothorax. The air requirement has fallen considerably, the obstruction of the air passages and the consolidation have disappeared, and the muscles of respiration have recovered from their exhaustion. The mediastinum has become thickened and stiffened by exudate and immobilized by adhesions so that it no longer has normal mobility, thus reducing greatly the effect of a

pneumothorax on the lung of the unoperated side. The presence of this condition may make the patient even a better operative risk than a normal man.

There is no Discrepancy between our Experimental Results and the Clinical Findings in War Wounds of the Thorax. During the past year the idea has become prevalent in this country that operations upon the thorax which permit of the free entrance and exit of air into the pleural cavity during the operation can be performed with about the same impunity as abdominal operations. In fact, the belief has arisen that surgeons at the front have found that alterations of the intrathoracic pressure by the admission of air through extensive incisions or large gaping wounds are in themselves not dangerous, and a feeling of optimism exists that now bold surgical intervention on the thorax may be carried out. It has been said consequently that the danger from creating an open pneumothorax in early operations for empyema with permanent drainage is negligible. These conceptions apparently have been largely based upon the address made a year ago at the Clinical Congress of Surgeons by Sir Berkeley Moynihan, a Colonel in the Royal Army Medical Corps. In the printed address Colonel Moynihan[17] bases his remarks chiefly upon articles by Duval, Depage, Gregoire, Elliott, etc. He says practically nothing about how extensive his own experience with wounds of the lungs and pleura has been, but he makes some remarkable statements which give the impression that the operator may attack the lungs boldly without heed to the danger of an open pneumothorax. For example, in discussing the open operation for extraction of foreign bodies he states that "no shock follows this operation," also, that during the operative incision of the pleura the free admission of air, "as a rule, causes no disturbance and does not alter the rate of the respirations or of the pulse."

On the other hand, reference to the work of Duval[18] and of others who have had extensive personal experience with this type of cases gives one a very different impression from that obtained from Moynihan's address, although at their hands also results were obtained which seem startling when compared with our ideas of the limitations of thoracic surgery before the present war. For instance, Duval's article, which is based on 3453 cases, shows that of all types of wounds of the chest the mortality is nearly twice as great in the gaping as in the closed wounds (27 and 15 per cent. respectively). The larger mortality of the gaping wounds is ascribed by Duval chiefly to the element of infection, but it seems highly probable that many of these may have died of the open pneumothorax, especially since, according to Duval, 50 per cent. of all lung wounds die within the first day, before the results of infection could have manifested themselves. Piéry states that the two gravest prognostic

[17] Gunshot Wounds of Lungs and Pleura, Surg., Gynec. and Obst., 1917, xxv, 605.

[18] The original was inaccessible to us, but extensive abstracts of the work of Duval and others may be found in the Review of War Surgery and Medicine, Office of the Surgeon-General, Washington, 1918, i, No. 4, 1–27.

elements are the large, open chest wound and generalized infection. "In discussing operative indications, Piéry[19] sounds a moderate note of conservatism when he points out that he considers it unfortunate that the early optimistic reports regarding the safety of lung surgery must in a measure be modified—in other words, one must bear in mind that surgery of the lung, in spite of the remarkable recent advance, is still surgery of a very grave sort." Both Duval and Piéry consider that the gaping wound must be closed in order to overcome the resultant mechanical embarrassment of respiration and the resultant pleural infection. As a matter of fact, according to them, closure is to be considered as an emergency operation.

As regards the operative attack on the lung itself it is to be noted that most surgeons with wide experience in war wounds of the lungs adopt measures which of necessity tend to limit the actual area of the opening into the pleural cavity and also to immobilize the mediastinum somewhat. In other words, they follow either consciously or unconsciously methods which our experiments show to be effective in reducing the danger arising from an open pneumothorax. For example, as a rule, the lung is drawn out through the thoracic incision a procedure which not only diminishes, if it does not actually plug, the opening into the pleura, but also tends to immobilize the mediastinum. Moreover, generally, the thoracic opening is plugged by a thick gauze compress after the delivery of the lung in order to obviate the to-and-fro movements of air during the operation. "It[20] is necessary to operate as gently and quickly as possible and to get the opening in the chest wall closed at the earliest possible moment. In case there should be any evidence of mechanical interference with breathing it is advisable rapidly to deliver the lung, plugging the chest wall with gauze. This procedure is usually followed by cessation of all respiratory embarrassment." Duval says that the closure of the chest wall must be done very carefully in order to avoid the leakage of air; the resected rib ends should be covered with muscle in order to get an air-tight wound. "Although the operation is described as sometimes remarkably simple it is, nevertheless, exceptional for these patients to run other than a rather stormy postoperative course." Roberts and Craig,[21] in a report based on 199 cases state that they operated upon "open" cases so soon as the condition of the patient permitted and that before doing that the great majority of cases in this class never reached the base. Anderson[22] in an experience in a British casualty clearing station found that the closure of an aperture in the wall of the thorax more than compensates for any risk which is accepted, and he emphasizes that the important matter is to get the chest completely closed. Gask and Wilkinson[23] in a report based on 500 cases of this type, also at a British casualty clearing station, adopted

[19] Quoted from Review of War Surgery and Medicine, loc. cit, p. 10.
[20] Quoted from the combined abstract in the Review of War Surgery and Medicine, loc. cit., p. 14. [21] Ibid, p. 18. [22] Ibid., p. 20. [23] Ibid., p. 22.

the routine of always closing large openings into the pleura through which air was sucked by temporary skin suture without an anesthetic. This was found to give the patient immediate relief.

It is evident, therefore, that from the experience of many surgeons in a very large series of war wounds of the chest the dangers arising from an open pneumothorax cannot be disregarded. On the contrary it is not surprising that otherwise healthy men can stand during the period of an operation a relatively large opening in the thorax, for in a previous section of this article it is shown that on the basis of calculations based on our experiments a healthy adult, without pneumonia and with good respiratory muscles, should be able to stand for a short time without death an opening of about 51.5 sq. cm. (5 x 10 cm., or 2 x 4.1 inches). It should be emphasized that, on the basis of our calculations, this is the largest possible opening compatible with life in the average healthy adult with a normal mediastinum, and that life can be maintained with so large an opening for only a short time. It is larger, however, than the usual area of an opening into the chest when an operation is made on the lung, especially when the opening is partly closed by the presence in the incision of a hand, the lung, a gauze pad or a number of instruments. *There is, therefore, no discrepancy between the deductions drawn from our experiments and the clinical observations on war wounds of the chest.*

Mechanism of Reaction to Change of Intrathoracic Pressure not Clear. The almost instantaneous response in the character of the respiratory movements which follows the creation of an open pneumothorax cannot be satisfactorily explained at the present time. It is very unlikely that asphyxia can account for it because the reaction occurs before any appreciable effect of asphyxia on the respiratory center can manifest itself. Also, that it is not due to the stimulation of nerve endings by the admission of cold air into the pleural cavity is shown by the fact that on several days when experiments were performed the temperature of the room was between 95° and 100° F. No noticeable difference was detected at this temperature and at lower temperatures.

Summary and Conclusions. From the standpoint of pressure relationships the normal thorax may be regarded as one cavity instead of two. Any change of pressure in one pleural cavity is accompanied by practically an equal change in the other so that an equilibrium of pressure exists at all times throughout the whole thorax. In our experiments the changes of intrapleural pressure have been accomplished only with air, but probably the same conclusions would hold for those effected by fluid.

The prevalent conceptions of pneumothorax are erroneous in that they are based on the assumption that when an opening is made into the chest one lung is collapsed and the other maintains respiration. This assumption implies that the mediastinum constitutes a rigid partition between the two pleural cavities. On the

contrary the mediastinum is so mobile that any increase of pressure in one pleural cavity pushes it over into the opposite one so that both lungs are compressed practically equally. No such condition is possible, therefore, of collapse of one lung and maintenance of respiration with the other in a chest with a normal mediastinum.

If, on the other hand, the mediastinum has been made rigid by induration as a result of long-standing inflammation, or if it has become fixed by adhesions, then a pleural opening on one side will not produce the same pressure changes in both pleural cavities.

The maximum opening into a pleural cavity compatible with life depends upon a definite relationship which exists between the amount of air entering the lungs and the amount which enters the pleural opening. The maximum opening compatible with life may be approximately determined for the normal chest by the mathematical expression given in the text. By this mathematical expression it is found that a normal human adult should be capable of withstanding for a short time an opening of about 51.5 sq. cm. (5 x 10 cm., or 2 x 4.1 inches). There is no discrepancy, therefore, between our experimental results and the finding at the front that men are capable of maintaining respiration with gaping thoracic wounds, which seem surprisingly large.

A double open pneumothorax in a normal chest is more dangerous to life than a unilateral open pneumothorax merely because usually the combined areas of the two openings (and therefore the amount of air admitted into the pleural cavities) is greater than a single opening on one side is likely to be. Theoretically and experimentally effects of practically the same severity result in the case of one or more openings into one pleural cavity as follow the creation of a double pneumothorax, provided that in each case the combined areas of the various openings are equal.

The bearings of these results and deductions upon both the treatment of acute empyema and upon thoracic surgery in general is obvious. Whenever the amount of air taken into the lungs is limited by the presence of an active pneumonia, with plugging of both air channels and alveoli, whenever there is an excessive demand for air, or whenever there is sufficient weakening of the respiratory muscles to impair compensation, the size of a pleural opening compatible with life becomes smaller; and if any or all of the above factors are present in sufficient intensity, even a very small opening into the pleural cavity will produce death from asphyxia. Since all of these factors are likely to be present to a high degree during the early stage of an empyema of the streptococcus type, early operation with the establishment of an open pneumothorax carries with it an unwarrantable danger. Aspiration is indicated instead until after the above dangerous factors have disappeared.

Special emphasis has been placed in this article on the changes of intrathoracic pressure induced by an open pneumothorax, but other results such as heat loss, danger of infection and disturbance of the systemic circulation are of great importance.

IRRITABLE HEART OR EFFORT SYNDROME.

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The medical work incidental to the selection of men for our new armies has brought new problems and novel experiences for all engaged in it, even for those who by reason of years of service in civil or military hospitals might justly consider themselves familiar with the various fields of clinical medicine. Especially is this true with relation to the physical signs and phenomena of heart affections. Not indeed that anything essentially new has been discovered, but rather that the methods employed, applied as they have been to many thousands of men called from civil life to the Colors, have brought new appreciation of the extent to which certain physical defects or disturbances prevail among our people and have compelled us to study these conditions from an entirely new view-point, that of the acceptability of the subject of such disabilities for military service. The problem has concerned prognosis rather than diagnosis, and its solution has been hedged about with anxiety, both for the welfare of the individual concerned and for the soundness and vigor of our armies.

To rightly value the facts set forth in this report certain considerations must be borne in mind. In the first place the men summoned for military service must have been subjected to most careful and repeated physical examinations. It is doubtless true that no army in the world has been put through so many tests to assure the physical soundness of its personnel. The men of the National Guard were not only examined by their regimental surgeons before being mustered into the Federal service, but were also gone over, man by man, by experts in the diagnosis of diseases of the heart and lungs. The drafted men were examined at the place of their enrolment and again at the camp to which they were assigned. In the case of any suspicion of disability they underwent a third examination at the hands of specialists in the particular field concerned. Finally, in all the camps during the past six or seven months, boards of specialists in tuberculosis have been engaged in going over the forces, man by man, for disease of the heart or lungs. In consequence of these methods it may safely be assumed that few indeed of the recruits presenting any abnormality of heart sound or action have escaped observation. As a corollary the numbers of those found or believed to be suffering from disease or disturbance of the heart has been impressively large.

The problem of the disposition of these cases has been one of the most difficult with which the army medical staff has had to deal. Their numbers made it a matter of importance that they should not be released from service without sound grounds for that action, and yet they could not be held without anxiety as to what the future might develop with regard to their suitability for service, especially in the event of their being sent overseas. The gravity of these questions has forced upon those concerned the most careful restudy and restatement of the criteria of both organic and functional heart affections and the most painstaking application of the conclusions to the individual case.

In this difficult undertaking we have had, as in all our preparations for this great war, the invaluable aid of the experience of the nations now our allies, and especially that of the British and Canadian armies. The results of that experience are embodied in the "Reports upon Soldiers Returned as Cases of 'Disordered Action of the Heart,' " or "Valvular Heart Disease," published under the auspices of the British Medical Research Committee. This report summarizes the work of a large group of investigators and covers, in a comprehensive manner, the whole subject of cardiac affections in relation to military service. From it has been taken the caption under which Dr. Thomas Lewis prefers to designate the particularly interesting group of cases previously described as "Cardiac Palpitation" or "Irritable Heart," which has been made the subject of our study.

The affection is by no means a new one. During our Civil War it was observed and studied thoroughly by Da Costa. The reader of his scholarly article[1] will at once see that he is dealing, in general, with the same class of cases that we are meeting today. Moreover, he finds some reference to the affection in the British reports on the Crimean War and very justly surmises that it has always prevailed among soldiers, but has heretofore escaped detection by reason of the difficulties of distinguishing it from organic lesions of the heart.

Da Costa gives the "general clinical history" of a considerable number of his cases as follows:

"A man who has been for some months or longer in active service would be seized with diarrhea, annoying, yet not severe enough to keep him out of the field; or if attacked with diarrhea and fever he rejoined, after a short stay in the hospital, his command and again underwent the exertions of a soldier's life. He soon noticed that he could not bear them as formerly; he got out of breath, could not keep up with his comrades; was annoyed with dizziness and palpitation and with pain in the chest; his accoutrements oppressed him, and all this though he appeared well and healthy. Seeking advice from the surgeon of his regiment it was decided that he was unfit for

[1] Irritable Heart, Am. Jour. Med. Sc., January, 1871.

duty, and he was sent to a hospital where his persistently quick-acting heart confirmed his story, though he looked like a man in sound condition. Any digestive disturbances which might have existed gradually passed away, but the irritability of the heart remained, and only very slowly did the excited organ return to its natural condition; or it failed to do so, notwithstanding the use of remedies which control the circulation; thus the case might go on for a long time and the patient, after having been the round of hospitals, would be discharged, or, as unfit for active duty, placed in the Invalid Corps."

With the exception that diarrhea or any other digestive disturbance is a rare antecedent, the above clinical picture is fairly representative of the condition as we have observed it.

In like manner his description of the symptoms and physical signs of the affection, both remarkably painstaking and accurate, for the most part, fit the conditions as we find them. His data being necessarily limited to the results of physical examination and clinical observation, without the instruments of precision whose use of recent years has added so much to our knowledge of the affections of the heart, he had included in his groups certain cases which we would now place in other categories. There are, for example, a few cases of auricular fibrillation and some also of probable myocarditis and cardiac hypertrophy. The great majority of his cases, however, appear to be identical with those presented in this report.

It is true, also, that Da Costa, though he notes in some instances that the disability had existed prior to the enlistment, and also states that he could parallel his observations among the soldiers with cases from private practice, nevertheless regards the affection as peculiarly related to the military life. One would infer that whatever examination was made before the acceptance of a recruit at that time it was not adequate to bring out the defect. In consequence this was discovered only when some acute illness or unusual exertion aggravated the disturbance and rendered the soldier unfit for duty. The careful medical supervision given our new armies brings out the fact that many of the recruits have this disturbance at the time of their reception and, as is pointed out in the present report, have had it for some years before their entry into the service. It therefore belongs to the soldier's life only in the sense that the physical exertions required of him, or the hardships or illnesses incident to his occupation, bring it to the fore.

The query naturally arises why, if this be true, the subject has received so little attention in clinical medicine since the publication of Da Costa's paper, and only the calling of great numbers of men to military service has again brought it into prominence and made it the subject of thorough study. The explanation would appear to be that, under the ordinary conditions of civil life, men suffering from this disability early become conscious that they are unequal

to heavy or exhausting physical labor and betake themselves to some form of occupation for which they are competent. In this way they make the best of the matter and get along tolerably well until such time as the disturbance in its natural course passes off. They only comparatively rarely present themselves for study or treatment and their affection under ordinary conditions receives scant attention. One may search the works of Babcock, Broadbent, Brockbank, Brunton, Hart, Mackenzie, Morison and even Lewis (until the report already referred to) without finding mention of the work of Da Costa or appreciation of the importance of the subject. In Hoover's article on "Irritable and Weakened Heart"[2] there is a paragraph devoted to Da Costa's observations.

In our present war conditions the subject becomes one of importance. In every camp one will find numbers of men suffering from this disorder under observation and study to determine the propriety of holding them for military service. No small part of the rejections for physical disability among the new recruits are made for this reason. For example, one-fifth of the rejections for cardiac complaints in Camp Dix up to February 1, 1918, had been made on this ground. In the exigencies of the present situation it was thought best to release many men from the service, although it was regarded as possible that by proper handling some of them might in time have been rendered fit. Efforts along these lines are now being made. It is therefore highly important to understand, as thoroughly as possible, the problem these patients present. The study embodied in this report was made to the end of increasing our knowledge of the condition and enabling us more effectively to deal with it.

While it has not been practicable to install the electrocardiograph in the base hospitals, the sphygmomanometer, the polygraph and the rotentgen rays have been available and have been freely used. With these aids to accurate diagnosis and the knowledge which recent intensive study of diseases of the heart has made common property we approach the differentiation of functional and organic affections of the heart with confidence, and in dealing with these patients we feel reasonably certain that careful study will enable us to exclude the presence of organic lesions and, in our handling of them, avoid doing them harm.

The observations herein reported were made upon cases sent to the cardiac consultant for office examination, not for observation in the hospital wards. This series includes most of the severer cases met with, but many of the milder cases have not been recorded here. In some instances only a single examination has been made; many of the cases have been seen twice and a number three or four times, the findings on subsequent examinations being practically identical

[2] Osler: Modern Medicine.

with those at the first visit. No case was diagnosed as of this type which presented any definite evidence of organic heart disease, and pulmonary tuberculosis, general neurasthenia and the tachycardia immediately following a febrile affection were carefully excluded. It was found very difficult to exclude hyperthyroidism, but when this diagnosis seemed reasonably certain it was made. Many of these cases were referred by the regimental surgeons for advice as to diagnosis and disposition; some were referred by the Board of Examiners for Tuberculosis, some by the Disability Board and a few by the ward surgeons of the Base Hospital. They were variously diagnosed as effort syndrome, chronic myocarditis, cardiac dilatation, simple tachycardia and valvular disease with poor compensation.

Occupation. A. Indoor occupations predominate.

Indoor	33 cases.
Outdoor	17 "

B. Little difference was noted as to whether sedentary, light or heavy work was engaged in.

Sedentary	14 cases.
Light	23 "
Heavy	13 "

Da Costa attributed no influence to the preceding occupation, remarking only that "painters, butchers, blacksmiths, carpenters, the city-bred man who had left his desk in the counting-house and the farmer fresh from tilling the fields were all fully represented in the long list of sufferers."

On the other hand the British Commission reports that of 543 instances in which this point was investigated, 57 per cent. were from light or sendentary occupations, 20 per cent. from moderately heavy employments and 23 per cent. from heavy work. They discuss these data in the following terms:

"The incidence is extraordinarily heavy among men engaged in indoor and sedentary work before the outbreak of the war. This fact may be accounted for in several ways: A large percentage of the patients were affected by the condition in civil life and years before joining the army; of these many had been forced to adopt sedentary occupations and had given up heavier work earlier in life because of their unfitness for it. The condition is commonest among civilians, often precluding heavy work; usually it does not preclude sedentary work or light work; affected civilians therefore tend to drift into these employments, and once they are so employed they are able to carry on with some slight degree of discomfort or they may be entirely free of symptoms. A history of each kind is common. Thus the men frequently relate that they were well once sedentary work was adopted, but they were unable to engage in outdoor games or exercises. But it is equally clear that a more considerable number

entered sedentary occupations for other reasons. Of these some became aware that they were unfit for violent exercise at a later date; others had never so tested themselves and the symptoms of these often date from the earliest days of training. It is unquestionable that many men recruited from sedentary occupations were affected by the condition before joining, although previous to that event in their life-history symptoms had never presented themselves. The question naturally arises as to what extent sedentary work actually predisposes to the affection; no conclusive answer can be returned from the data at our disposal, though they strongly suggest sedentary work as a predisposing cause. The incidence of infective disease among clerks is heavy.

"To what extent training may rid men of a predisposition to or early manifestations of the condition is also uncertain; not a few patients have related that symptoms, previously experienced, disappeared early in training to return later on active service, but the number of men who enjoy a similar early experience and endure active service without recurrence of the symptoms is unknown.

"The facts now brought forward strongly suggest that, were it possible, it would be wise in conscripting men from sedentary occupations to arrange a more thorough initial medical scrutiny and subsequently to train such as are passed for service by tenderer methods in the initial stages than those in vogue for conscripts as a whole.

"The class of military invalid with which we are dealing is a very large one; it is a very unsatisfactory one on the score of expense and time lost in training and in hospitals. It cannot be too strongly emphasized, therefore, that more than half of this class is drawn from sedentary or light occupations."

1. *Previous Disease.* Inquiry elicited the following data:

Measles	34 cases.
Rheumatism	16 "
Scarlet fever	11 "
Tonsillitis	14 "
Pertussis	9 "
Pneumonia	4 "
Diphtheria	6 "
Typhoid fever	5 "
Appendicitis	2 "
Other infections	3 "
No disease	7 "

While at first sight these figures would suggest a very direct and intimate relation between some preceding infection and the effort syndrome-complex, more careful study did not bear out this inference. The attempt was made in every instance to ascertain what the patient considered was responsible for the onset of his trouble, but in only 8 of the 50 cases could a definite cause be assigned. In 6 of these acute infection was regarded as the exciting cause, diphtheria

in 3 cases, pneumonia, rheumatism and bronchitis 1 each. The other cases started from a mental shock, 1 from the sudden death of a parent and 1 after being told at an examination for insurance that his heart was weak.

Remembering that our data refer to men examined at the very beginning of their service it is of interest and importance to compare them with those derived from men longer in service. From Da Costa the following table of antecedent conditions is taken:

ANALYSIS OF 200 CASES

Fevers (typhoid and typhomalarial)	17.0 per cent.
Diarrhea (typhoid and typhomalarial)	30.5 "
Hard field service, excessive marching	38.5 "
Wounds, injuries, rheumatism, scurvy, ordinary duties of the soldier's life and doubtful causes	18.0 "

The findings of the British Commission may be summarized thus: In 182 of a total of 558 patients examined the symptoms of the affections were first noted during convalescence from some acute infection, that is, in 33 per cent. of the cases. After further consideration of their observations they conclude that these figures by no means represent the full truth, but that in at least 50 per cent. to 60 per cent. of the cases infectious disease may be held to play the chief part in promoting the disease in its initial stages.

ANALYSIS OF 182 CASES.

Rheumatic fever or chorea	68 cases or 12 per cent. of total 558
Dysentery	14 cases or 2.5 per cent.
Typhoid fever and diarrhea	14 cases or 2.5 per cent.
Pneumonia, pleurisy and bronchitis	25 cases or 4.4 per cent.
Fever or influenza	28 cases or 5.0 per cent.
Diphtheria, scarlet fever and pus infections	33 cases or 6.0 per cent.
	33.0 per cent.

The role assigned to rheumatic fever in this tabulation is impressive, but they add that of the remaining 376 patients those in whom no close relation between the infectious disease and the disorder could be established at least 65 definitely belonged in the rheumatic class, although the precise significance of rheumatism in relation to the malady is in many of them uncertain.

Grouping all these observations it appears clear that no one infectious disease, or type of infection, is to be regarded as having an essential relation to the affection. During the Civil War it was the fevers and diarrheas, then prevalent, that were accused; among the British troops rheumatic fever comes to the fore, just as it does in all their health studies; with us it will doubtless prove to be infections of another type.

During the past winter we have had frequent opportunities in the

wards of the hospital to observe the influence of intercurrent acute infections in patients already subject to this affection. Under these conditions the disturbance is aggravated, convalescence is protracted and not infrequently the symptoms have become so severe and persistent as to lead to the discharge of the patient from the service.

2. *Shock.* No little interest attaches to the two cases in which the onset of the affection was attributed to mental shock, in one case the sudden death of a parent, in the other the alarm caused by the patient's being told at an examination for life insurance that his heart was weak. If the affection were a pure neurosis one would certainly expect that such experiences would play a much larger part in the causation. From the British report we learn that of their 558 cases but 13 (2 per cent.) dated the onset from shell shock or mine explosion, and that in two of this small number of cases duty was carried on until an infection sufficiently aggravated the symptoms to warrant invaliding. It would therefore appear that of the two factors antecedent infection is the much more effective in inducing the disturbances of which these patients complain.

Duration of Symptoms. Perhaps the most important finding in our own study lies in the fact that in all but one of the fifty cases the patient had suffered from cardiac symptoms for some time previous to entering the army, although in most of the cases the trouble had been aggravated by army training. Of considerable interest from the view-point of prognosis is the question of the length of time during which the disturbance had existed before the soldier's enrolment. In our series this was as follows:

Under 1 year	2 cases.
1 to 5 years	30 "
Over 5 years	12 "
Indeterminate	6 "

Without doubt the longer the condition has existed the longer the treatment required to restore the subject to normal, the more remote the prospect of ultimate success and the greater the likelihood that even if recovery occurs any new strain or new infection will cause a return of the symptoms and in the end lead to the discharge of the recruit.

Since these chronic or long-standing cases are those we at present have to deal with in our camps, and it is of the utmost importance to us to determine, so far as we may, the outlook for them and their ultimate value to the military service, it may be well to quote at length a page of the British report dealing with these problems:

"Taking all patients invalided, symptoms of the condition were present in 43 per cent. at the time the men joined the service (average duration of symptoms, nine years); 12 per cent. acquired their first symptoms on training and 45 per cent. on active service.

"Of men in whom the symptoms are acquired before joining, the

duration of training added to the stay in hospitals averages 11.3 months; the total duty performed on foreign service (light and full) averages 3.9 months. In those in whom the onset is on training the average total of training and stay in hospitals is 12.3 months; the total duty performed on foreign service averages 2.9 months. The smaller amount of foreign service completed by the men in whom the onset is on training is due to the fact that only 46 per cent. of them have seen foreign service, while of those in whom the onset was before joining 63 per cent. have seen foreign service.

"From these figures it might appear that those who have symptoms on joining are more favorable, from the military stand-point, than those who develop symptoms on training. But this conclusion is not borne out by the analysis of the categories of discharge from the hospital, for of the former 36 per cent. return to duty (10 per cent. in the full-duty category) while of the latter 52 per cent. return to duty (32 per cent. in the full-duty categories). When the onset of symptoms is on training the condition is more acute and for the moment somewhat more incapacitating, but the recovery is more rapid and more satisfactory.

"The group in which the onset is on active service a group in which the duration of symptoms is but a few months do best of all; of these 60 per cent. return to duty (35 per cent. in the full-duty categories).

"To sum up: where the disability is of long duration it is relatively mild during the initial stages of training and service; a large percentage of these men see active service abroad. But if the condition changes for the worse in these men, recovery is slower and more unsatisfactory than in those in whom a similar degree of disability has arisen more recently."

In the light of these facts it would seem questionable policy to permit any of these men who have had their disability for years before entering the army to be sent abroad; they should, at any rate, not be regarded as fit for full duty.

Other Etiological Factors. Tea and Coffee. Inquiry failed to reveal anything of significance in this relation. Seven of the fifty men used none at all, a rather remarkable return, since coffee is so regularly regarded as an essential of the soldier's diet. But one man used more than three cups of coffee during the day. Doubtless this moderation or dislike is determined largely by the results of experience, in that the men find they are more comfortable without this particular form of stimulation.

Tobacco. In view of the widespread tendency to lay the responsibility for any cardiac rapidity or irregularity at the door of Lady Nicotine, careful inquiry was made as to the use of tobacco: 7 of the 50 did not use it at all; 23 smoked very moderately; 14 used from ten to twenty cigarettes a day; 6 only admitted smoking more than twenty daily. Again, there is little question that this moderation is

dictated by experience, but it leaves no ground for assuming that tobacco plays any part of consequence in the production of the malady. The British Commission reports a like conclusion from their investigation of this subject and also quotes McGregor to the effect that the condition is as frequently found among the Sikhs, who are non-smokers, as among the other races in their armies.

Alcohol. Still more remarkable are the replies to questions on this point, tabulated as follows:

To excess	4 cases.
Moderate	21 "
Abstainers	25 "

Similarly in the British study of 454 cases 52 per cent. were total abstainers. Self-protection against unpleasant results of indulgence is probably in part responsible for this restraint, but there are doubtless many other factors. Many of the men are obstainers by conviction; many of them do not now use alcohol because it is not easily to be had. In Camp Dix intoxication was practically unknown except in the case of newly drafted men. While alcohol certainly aggravates the symptoms in these patients its use is not an important factor in the causation. This fact is rather curiously enforced by the figures in the British report, which show that in these "effort syndrome" cases return to duty are much more frequent among the heavy drinkers than among the abstainers. Relieved of the injury done by alcohol they make a more satisfactory recovery than the abstainers, who present no such *point d'appui* to therapeutics.

Symptoms. Dyspnea and precordial pain were almost constant symptoms and one or the other was given as the chief complaint in nearly all the cases. The results of our study may be shown thus:

	Present.	Absent.	Predominating.
Dyspnea on exertion	50	0	18
Pain	48	2	19
Exhaustion	43	7	4
Giddiness of fainting	47	3	1
Palpitation	49	1	8
Orthopnea or smothering at night	17	33	0

Nervousness. The patients were questioned as to whether they considered themselves nervous, and answered as follows: Very nervous, 23; somewhat, 16; slightly, 8; not at all, 3.

A glance at the table shows clearly the constancy of the characteristic symptoms. The studies both of Da Costa and the British investigators have brought out many interesting details of the several symptoms, but for our present purposes the above enumeration suffices.

Physical Signs. Heart Rate. This was taken (1) three or four minutes after the patient had entered the examining room and while he was still standing; (2) after he had been lying supine for two or

three minutes; (3) after exercise consisting in all cases in jumping up and down on one foot one hundred times. Rate per minute was here estimated on the count for the first ten seconds after the exercise was completed; (4) rate per minute estimated on a ten-second period counted one minute after exercise was completed; (5) a similar count three minutes after the completion of the exercise. It was found that there was a difference of more than fifteen beats per minute in 24 cases and less than ten beats per minute in only 12 cases. There was well-marked delay in the fall of the rate after exercise in 22 cases.

	120 per minute or over.	100 to 120.	Under 100.
Standing	19	21	10
Dorsal	4	19	27
After exercise, 1 minute	36	9	5
After exercise, 3 minutes	22	6	

Immediately after the exercise the pulse rate was tabulated thus:

150 per minute or over.	130 to 150.	Under 130.
25	21	4

The abnormal response to simple exercise is well shown in these tables, especially the persistence of rapidity beyond the normal period of recovery (two minutes).

Blood-pressure. This was uniformly taken with the patient sitting upright and always before exercise.

Systolic blood-pressure over 140	32 cases.
Diastolic blood-pressure over 100	7 "
Pulse-pressure over 60	16 "

The systolic blood-pressure therefore tends to be slightly higher than normal, but this rise rarely exceeds 170 mm. The diastolic pressure shows less tendency to rise above the normal than the systolic and the rise is usually less. The pulse-pressure occasionally exceeds the normal limits. In other words, while there is a tendency to modifications of the blood-pressure relations the changes in pressure are not sufficient to be of moment.

Size of Heart. This was estimated by the palpation of the apex impulse and percussion of the borders. Slight hypertrophy was noted in 19 cases; in 36 the results were normal. Meakins and Gunson report observations of peculiar interest along this line. They find the size of the heart, determined by the orthodiagram, to be normal in these cases, but they also find that in these patients exercise acts exactly as in normal individuals, confirming the findings of de la Camp, Moritz, Nicolai and Zuntz that the heart is smaller than before. These observations seem to dispose finally of the hypothesis that these soldiers are suffering from heart-strain, the results of overexercise, and that this strain has induced dilatation of the heart.

Irregularity of the Pulse. Extrasystoles were observed in 1 case, sinus arrhythmia in 9 cases and none at all in 40. It is in this category that the recent advances in the knowledge of cardiac affections enables us to work much more surely than was possible in Da Costa's day. We can say with assurance that the irregularities observed were of practically no importance and should not influence us in judging the functional efficiency of the heart or the propriety of holding the subject for service.

Deep tenderness to percussion over the apex region. This was present in 21 cases and absent in 19. Precordial areas of skin hyperesthesia were likewise present in 21 cases and absent in 19. The British Commission find that hyperalgesia is an important sign in these patients, those who have it to a notable degree showing a low capacity for work and a correspondingly poor prognosis.

Murmurs. These were observed as follows:

Systolic at apex	16 cases.
Systolic at base	2 "
Cardiorespiratory	3 "
None	29 "

None of the murmurs heard was considered as due to organic valvular disease.

It is, of course, true that there is little harmony as to what would constitute reliable criteria for a final distinction between functional and organic murmurs. In the early stages of the work these patients were regularly sent for examination with the diagnosis of mitral insufficiency or other valvular lesion. In judging the character of a murmur the history (especially of previous rheumatism), the size and action of the heart, pulse frequency and quality, blood-pressure, the location and quality of the murmur and the response to exercise were all taken into account. No part of the work of the British Commission is more striking than their conclusions as to the value of cardiac murmurs in estimating the efficiency of the heart. These are so important as to warrant their being quoted in full:

"Cardiac Murmurs. When a soldier presents the characteristic low-pitched rumbling murmur in diastole and at the apex beat, or when an early diastolic murmur, maximal at the level of the second costal cartilage, is associated with the water-hammer pulse, then, by common consent, he is unfit for duty. Instances of systolic murmurs at base or apex cannot be similarly treated. In the absence of other disqualifying signs or symptoms it is wise to entirely neglect such murmurs in soldiers. This conclusion is at variance with much current teaching and the reasons for insistence upon it are therefore given in full.

"(*a*) Systolic murmurs at base or apex indicate valvular disease only exceptionally; there is no conformity of opinion to the character or conduction of systolic murmurs indicating valvular lesion.

"(*b*) The extent of mitral valve damage which produces a systolic murmur alone is relatively slight; the disease is often limited to the valve, the heart muscle, which is the essential part of the organ, being wholly undamaged.

"(*c*) Patients who are invalided on the ground of systolic murmurs alone are subsequently found when tested to be fit for service in nearly all instances. A large number of men who present such murmurs are known to have passed the most severe ordeals of active service without accident.

"(*d*) If a group of patients who present no murmurs and a similar group in whom systolic murmurs exist are tested in respect to their capacity for work or active service no difference is to be found in the capacity of the two groups.

"The estimate of fitness or unfitness for service can be gauged with considerable accuracy without reference to such murmurs; as soon as murmurs of systolic time are taken into consideration the issue becomes confused."

Accentuation of the First Sound and Diffusion of the Apex Beat. The first sound was accentuated in 31 cases; in 11 the apex impulse was diffuse. The first sound was normal, with no diffusion of the apex beat in 16 cases. Diffusion of the apex beat and a forcible impulse have long been regarded as indications of hypertrophy, but the orthodiagrammatic studies made under the British Commission show them to be unreliable either as indications of the size of the heart or of its functional capabilities.

Erben's Sign. This consists in a marked retardation of the pulse-rate, when the patient squats on his heels and bends the head well forward between the knees. The pulse is first counted for fifteen seconds, the patient standing; he then assumes the squatting position and bends the head well forward; the pulse is then counted again for three consecutive five-second periods. This maneuver produces no retardation in cases of tachycardia due to febrile conditions or myocardial disease, but it is usually quite pronounced in the nervous cases. Thus in pulses averaging 120 to the minute or 10 to each five seconds the readings for the three five-second periods immediately following the assumption of this position will run: −5, 6, 7, −6, 7, 8, −6, 6, 6, etc. This phenomenon, sphygmographically demonstrable, is said by Erben to be caused by the stimulation of the pneumogastric produced by reason of the venous congestion of the brain. There are doubtless other factors in the production of the retardation, such as the increased abdominal pressure with pressure on the splanchnic nerves and vessels and possibly the indirect pressure upon the heart itself. Certainly the retardation is greater than that produced by merely lying down or even by having the patient, while lying on a bench, let the head fall as far down ward over the edge of the bench as possible. Whatever the explanation it appears to be a fact that marked retardation in the Erben

position is characteristic of the "effort syndrome" cases, and is not present to the same degree, at least, in tachycardia due to organic disease. The occurrence of this marked retardation in this position has suggested that exercises involving this and similar movements might have special value in the treatment of the condition. This idea it has not yet been possible to try out.

Thyroid Gland. It has already been stated that when the diagnosis of hyperthyroidism seemed warranted it was made and the cases so classified were not included in this present series. Practically the history of the case and the presence or absence of the traditional eye signs of Graves's disease decided the group into which any questionable case should be put. Apart from the cases classed as hyperthyroidism the involvement of the thyroid was found as follows:

Slight general enlargement	11 cases.
Isthmus alone enlarged	7 "
No enlargement	32 "

Some would undoubtedly at once transfer all these cases showing any increase in size of the thyroid to the class of hyperthyroidism. That has not seemed justifiable on clinical grounds. Lewis's observations that feeding thyroid gland to the patients suffering from "effort syndrome," they react, as do normal persons and not after the manner of the hyperthyroids, would appear to settle the debate as to whether all these patients belong in the latter category.

Sweating, cyanosis of the hands and tremor of the fingers were also recorded as follows:

	Slight.	Marked.	Very marked.	Absent.
Sweating	8	25	12	5
Cyanosis of hands	12	21	3	14
Tremor of fingers	15	14	1	20

Again, these symptoms would by the radical be regarded as determining the diagnosis in the cases in which they are present, but they occur so often quite apart from any other evidence of involvement of the thyroid gland that we have been cautious as interpreting them in that sense.

Knee-jerks. The observations on this point were made with the thought that these reflexes are usually a reliable index of the tonus of the nervous system. There was a markedly exaggerated response in only 4 of the cases, a slight exaggeration in 24 and a normal response in 22 cases.

Condition of Tonsils and Teeth. In these days of tireless zeal in the search for original foci of infection no inquiry is complete without reference to the integrity of these parts. The teeth were reported as good in 31 cases, fair in 8 and bad in 11 cases.

The tonsils were found small in 30 cases, slightly hypertrophied in 10 and greatly hypertrophied in 10 cases.

Needless to say it should be regarded as of first importance to see that such handicaps as diseased teeth or tonsils should be removed, although it is not probable that such treatment will be followed by any appreciable change in the pulse rate or other symptoms in these patients.

Nature of the Affection. This is still a moot question. Da Costa regarded it as an irritability of the heart, maintained by a disordered nervous system, but could go no further in his explanation of the symptoms. In the light of our present conceptions of physiology and pathology some suggest hyperthyroidism, others increased adrenal activity as the explanation of the phenomena. Bacteremia has been suggested but not proved. Reviewing these various opinions the British Commission inclines to the belief that the disturbance may be a chronic toxemia or disturbance of metabolism, the result possibly of a previous infection, but find many difficulties in frankly committing themselves to this hypothesis. It may fairly be said that we at present have no knowledge of the causations of the disease which determines clearly the therapeutic measures to be applied to it. As the results of his experience Da Costa put special value upon rest and digitalis. The British Commission find both these measures useless and possibly harmful. They advocate progressive physical training and lay out a carefully graded system of exercises through which the patients are passed. We have as yet no sufficient experience of our own and must for the present follow the lines of procedure laid down as the result of their careful study of many hundreds of cases. It may only be surmised that Da Costa's conclusion in favor of rest and digitalis sprang from the fact that he had included among his cases a sufficient number of instances of auricular fibrillation to influence his judgment of the entire group. He notes that digitalis failed of effect in many cases.

The inferences drawn from this study may be summarized as follows:

1. The irritable heart or effort syndrome cases constitute a symptom-complex rather than a definite disease. It seems clear there is no definite disease of the heart, and we agree with Lewis that it is highly desirable to avoid any terminology which suggests that there is.

2. The affection is not peculiar to soldiers but often precedes entry into service, though it may be exaggerated or in some cases produced by the active exercise or vicissitudes of the military life.

3. Occupation in civil life is as much a result as a cause of the disturbance, in that men who know their weakness usually adopt an employment suited to it.

4. In the great majority of cases no definite cause of the disorder is ascertainable. When such can be found it is most often an acute infection.

5. Tobacco, alcohol, coffee and tea, though possible causes of aggravation of the symptoms, cannot be regarded as prime factors in the causation.

6. Hyperthyroidism is suggested in some of the cases, but if present it is in a mild degree, and there seems no valid ground for regarding it as more than a contributory factor.

7. In the light of the experience now available in the studies of Da Costa and the British Commission it would seem wise to retain many of these patients in the hope of rendering them fit for duty of some kind. In view of their very limited usefulness in foreign service they should not be sent abroad.

8. For the present, at least, the line of treatment must be that of progressive physical training as laid down by the British Commission, which, even if it fails to produce satisfactory therapeutic results offers the best means of classifying the men as to their physical ability to perform military service.

CLINICAL REPORT UPON CASES OF LOBAR PNEUMONIA TREATED WITH ANTIPNEUMOCOCCUS SERUM AS OBSERVED AT GENERAL HOSPITAL NO. 6, FORT MCPHERSON, GEORGIA, OCTOBER, 1917, TO MAY, 1918.

By Lieut.-Colonel C. N. B. Camac, M.C., U.S.A.,
NEW YORK.

This report deals especially with cases which were diagnosed clinically, bacteriologically and by postmortem as lobar pneumonia due to the pneumococcus. Reference is made to cases which were given antipneumococcus serum but which at autopsy were shown not to be lobar consolidation. There are added also cases of infection with streptococcus hemolyticus, but these are included by way of contrast only, our conclusion being that cases of pneumococcus infection present clinical features quite different from those of streptococcus infection. Streptococcus may be, and frequently is, superimposed upon the pneumococcus or may occur separately. Whether separate or in conjunction with the pneumococcus we believe that the clinical features are differentiable in the majority of cases.

We have looked upon the mixed infections as similar to the complicating infection of pyogenic organisms in typhoid or smallpox. Moreover, we have felt that bronchopneumonia should not be considered as having anything to do with lobar pneumonia any more than the tuberculous ulcer of the intestine should be considered in connection with typhoid ulcer except to show the difference. The pneumococcus infection of whatever type when treated at the outset

with serum, in our experience, does well. When treated late it assumes all the serious features with which we were familiar before serum was used when the mortality ranged from 20 to 50 per cent. From bacteriological findings we have concluded that those cases which were treated late became, through the action of the pneumococcus, fertile soil for the pyogenic organism or at least reduced the resistance to such an extent that the pyogenic organism found non-resistant soil in which to flourish. We have been unable to demonstrate whether these pyogenic organisms were previously lodged in the individual, in the throat, for example, or whether they gained access during the pneumococcus infection. We have on meager evidence inclined to the former. The serious pulmonary sequel to measles, which is so fatal in military hospitals, we have considered as a disease distinct and separate from the pneumococcus lobar pneumonia. In our experience the pneumococcus has been an extremely rare complicating infection in measles. I will not consider further this pulmonary complication of measles, for it is so different clinically, anatomically and bacteriologically that it belongs to a separate discussion. The report of "pneumonia" as a complication or cause of death in measles should be abandoned as incorrect and misleading. The Surgeon-General's Office has adopted the term "measles pneumonia," but we believe that the term "pneumonia" should not be used at all in this connection.

From the statistics of the Rockefeller Hospital and from the review of our 139 cases we feel that the pneumococcus pneumonia when treated with the serum early is a comparatively mild infection. I would like to repeat that this report deals with those cases which show, clinically, consolidation of part or of an entire lobe of the lung and due to the pneumococcus.

SUMMARY OF CASES.

I. Pneumococcus Alone.

Type uncomplicated.	Incidence.	Recoveries.	Deaths.	Mortality. Per cent.
Type 1	26	25	1	3.8
Type 2	18	17	1	5.5
Type 3	10	10	0	0.0
Type 4	27	27	0	0.0
Total	81	79	2	2.4

It is noteworthy that the two fatal cases were colored and both worked as stevedores. Nephritis complicated the pneumonia in both cases, the one of chronic type the other an acute nephritis developing during the height of the disease. Each received large doses of serum on and after the fifth day of the disease. At necropsy each showed the characteristic lobar consolidation and the evidence of nephritis in addition.

II. Pneumococcus and Streptococcus.

	Incidence.	Recoveries.	Deaths.	Mortality. Per cent.
Type 1	3	2	1	33.0
Type 2	0	0	0	0.0
Type 3	0	0	0	0.0
Type 4	2	1	1	50.0
Total	5	3	2	40.0

III. Streptococcus Alone (Hemolyticus or Viridans).

11	5	6	54.0

IV. Undetermined (Not Pneumococcus or Streptococcus).

39	38	1	2.2

V. Miscellaneous.

Pneumo Type 1 and 2	1	1	0	0.0
B. influenza	1	1	0	0.0
Staphylococcus in throat	1	1	0	0.0
Grand total	139	128	11	7.9

Method of Procedure. Immediately upon the finding of clinical signs indicating an area of consolidation the patient is desensitized with polyvalent antipneumococcus serum (Mulford's) and placed in a pneumonia ward, where the following instructions are posted and strictly adhered to:

Instructions—Medical Service.

INSTRUCTIONS TO THE MEDICAL STAFF REGARDING ALL CASES OF LOBAR PNEUMONIA.

"1. Isolation: Caps, gowns and gauze mouth guards for attendants, nurses and doctors. Sheets between beds and mouth guards for patients leaving bed.

2. Sputum: (*a*) Collect sputum in sterile bottles and send to the pathologist at the clinical laboratory for transmission to the department laboratory. (*b*) Laboratory slip marked as follows must accompany the sputum. 'Sputum for determination of pneumococcus type.' (*c*) The specimen must reach the department laboratory within four hours after it has been expectorated.

3. Urine: Collect 6 ounces of the twenty-four hours' specimen in sterile bottle and send to the pathologist at the clinical laboratory for transmission to the department laboratory. A laboratory slip marked as follows must accompany the specimen: 'Urine for Pneumococcus Differentiation.'

INSTRUCTIONS FOR SUCH CASES OF LOBAR PNEUMONIA AS ARE TO RECEIVE SERUM TREATMENT.

Desensitizing: (*a*) Administer 2 c.c. of serum subcutaneously and at two hours' interval administer the following amounts: 3 c.c. and 5 c.c., a total of 10 c.c. After each administration look for signs of hypersensitiveness, such as: (1) Difficulty in respiration. (2) Cyanosis. (3) Violent coughing. (4) Sense of restriction about chest. (5) Marked variation in pulse. In case these occur give same dose as previous one at the end of two hours' interval. (*b*) From two to four hours after the last desensitizing dose, administer the balance of the 100 c.c. intravenously. (*c*) Administer 100 c.c. intravenously every twelve hours. The intravenous administration of serum, warmed to body heat, should be by gravity, and very slowly. In case of signs of hypersensitiveness, as noted above, occurring during the administration of serum, stop the serum at once.

Serum Sickness. This is not a serious condition and does not contraindicate the continued administration of serum, though it is due to the serum.

The manifestations are fever, itching and redness of skin, urticaria. This condition is entirely different from true anaphylaxis, which in mild form would be manifested by the symptoms of hypersensitiveness noted above and which in severe form may be rapidly fatal."

In the early part of the winter our laboratory facilities were inadequate and it required considerable time to get a report on the sputum from the department laboratory, four miles away. This inadequacy still exists on account of the difficulty in procuring mice and the need of a larger laboratory and staff of laboratory workers. The patients, however, did not suffer in consequence, as the polyvalent serum were administered without waiting for laboratory findings. If the report Type I was returned the patient received Type I serum, otherwise the polyvalent serum was continued. The polyvalent serum used has been prepared according to Mulford, so as to prevent the neutralizing of the Type I element, so that in giving the polyvalent serum, Type I, in full strength is being given, if Mulford's claim is correct. We have no proof of this beyond our clinical results. We believe too that by using the small doses to desensitize the patient is better prepared for the larger doses and the danger of anaphylaxis is minimized. We have preferred the subcutaneous to the intradermal method because with the varying personnel in a military hospital we consider it safer to desensitize than to attempt to ascertain the sensitiveness of the subject with possible grave errors in judgment. Even with the trained observers at the Rockefeller Hospital such errors in judgment are reported by Cole.[1]

[1] Ref. monograph Acute Lobar Pneumonia, Rockefeller Institute, No. 7, October 16, 1917, p. 63.

Clinical Features. The three striking features have been: (1) Variations in temperature. (2) The rapid recovery. (3) Absence of profound toxic effects.

The rapid breathing, flushed face and further manifestations of profound toxemia have been absent in the majority of our cases unless complicated by some other septic organism. A careful inspection of our temperature charts fails to reveal any uniformity of the lobar pneumonia curve. Invasion by another organism is usually accompanied by a greater variation in the curve, but a number of the cases in which no other organism could be demonstrated have shown a temperature decline with a step like lysis similar to that of typhoid but without the long typhoid period of decline. Extension of the pneumonic process or involvement of another lobe is marked by a sharper and more sustained rise, whereas invasion by another pyogenic organism presents a more gradual rise and shows greater variations. About 5 per cent. of the cases show the sustained temperature with the sharp critical fall commonly described as characteristic of the pneumonia curve. The leukocyte count, beyond indicating a good prognosis when high, has been no guide as to the development of complications or extension of the process.

Complications. Empyema and otitis media have been the most frequent. The former of these will be dealt with in a separate report. Two cases presented pneumococcus abscesses of the abdominal wall. Streptococcus pericarditis occurred in two cases. Mediastinal abscess in one case. Meningitis in one case only. This case will be described under the Fatal Cases. Acute nephritis occurred in about 15 per cent., as evidenced by albumin and casts in uncomplicated cases; 75 per cent. in complicated cases.

Serum Treatment. The amounts of serum administered have varied between 50 c.c. and 600 c.c., with an average of 250 c.c. About 10 per cent. of the cases did not require serum treatment. In the military service it is possible to begin the serum treatment much earlier than in civil practice. Few of our cases have come under treatment later than the third or fourth day, and many of them have been treated in the first forty-eight hours. Treatment was begun on the first clinical sign, without waiting for differentiation of type. For this purpose polyvalent serum was used. If the case showed Type I this serum was used, otherwise polyvalent serum was continued. No systematic blood cultures were made on our cases, but from the Rockefeller report[2] and from our low mortality we concluded that the early administration of serum prevented the development of or cleared the blood of pneumococcus organisms. In the few cases in which blood cultures were made this conclusion was supported. The rapid recovery of between 50 and 60 per cent. of all cases would indicate that the

[2] Monographs of the Rockefeller Institute for Medical Research No. 7, October 16, 1917, p. 79.

early use of serum tends to diminish the frequency of the complications.

Preventive Treatment. Dichloramin-T in chlorcosane 2 per cent. was used as a throat spray for attendants and with some of the cases. With the measles cases we found that pulmonary complications were less frequent when this treatment was employed.

Serum Sickness. About 50 per cent. of the cases showed signs of serum reaction. These ranged from simple erythema to the extensive urticaria, with general swelling and joint pains. Some of the severer cases developed after 50 c.c. of serum had been given and others showed no reaction after 400 to 600 c.c. Manifestations appeared from twelve hours to fourteen days after administration. Only 2 cases showed any alarming features. One of these had blood and blood casts and excessive amount of albumin in the urine. The other, who received only 50 c.c. of serum, with prompt fall of temperature which remained normal, two weeks later developed general swelling, making him unrecognizable, together with swelling and pains of many of the large and small joints and with albumin and hyaline casts in the urine, all of which disappeared in five or six days. In some of the cases we have endeavored to determine whether a mononuclear increase in the blood would indicate a serum rise of temperature, as suggested by Cole, but we found no uniformity in this from which conclusions could be drawn.

Anaphylaxis. Only 1 case presented symptoms of anaphylaxis. This was a case of asthma of unknown cause. In desensitizing him he showed no reaction, but when 80 c.c. of serum had been administered, cyanosis, dyspnea with asthmatic breathing, cold sweat, disturbed, rapid heart action and general signs of collapse developed. Administration of serum was continued up to 100 c.c., and subcutaneous injection of adrenalin was given. In twelve hours the temperature was normal and continued so, requiring no further treatment.

Streptococcus Infection Alone and Complicating Pneumococcus. Reference to the Table will show the frequency of these conditions. We have not practised streptococcus vaccination. With the accumulation of evidence it is becoming more and more apparent that when this organism is added to pneumococcus infection the case assumes grave features. To combat this added infection we are preparing to carry out immunization with streptococcus vaccines. This measure has been resorted to in some of our base hospitals and is suggested by Cole and MacCallum in a recent communication.[3] The destructive power of the streptococcus is well demonstrated in the pulmonary complication of measles, in which the pneumococcus is rarely found. In reviewing the records one is disposed to conclude that it is the streptococcus, superimposed upon pneumococcus, that gives lobar pneumococcus pneumonia its real virulence. Early

[3] Jour. Am. Med. Assn., April 20, 1918, No. 16, lxx, 1151.

treatment with serum seems to lessen the tendency toward the development of this mixed infection. While slight tinging of the conjunctiva is common in this disease we found marked jaundice of the conjunctiva in those cases of streptococcus infection alone or complicating pneumonia.

Other Treatment. Diet: While this is a comparatively brief febrile disease we have felt it advisable to maintain a diet of about 2000 calories, consisting of easily digested fluids and semisolids; 3000 c.c. or more of water a day is routinely given. Whisky has been given when indicated.

Heart Stimulants: We have in most cases followed the advice contained in the Rockefeller monograph, namely, digitalizing early. We have used Merck's digipuratum tablets, 1½ grains each. One such tablet given three times a day for *three days*. Strychnin was not given.

Abdominal Distention: This has been an infrequent feature. In 3 of the cases peritonitis was suspected and was found at autopsy in 1 of these. By the use of oil and turpentine stupes, enemata and by the regulation of diet the distention was relieved in most cases.

Open Air: For the greater part of the winter, patients were moved to verandas and allowed to remain there from 11 A.M. to 4 P.M., protected by screens. (Lobar cases only.)

IMPORTANT POINTS. 1. Early diagnosis is essential.

2. Clinical signs of consolidation should be followed by immediate use of polyvalent or other serum.

3. If more than 250 c.c. of serum are required and the temperature and toxic signs continue, complication by other organism should be suspected; like malaria when treated with quinin the pneumococcus is rapidly overcome by serum.

4. Uncomplicated pneumococcus infection is a comparatively harmless and rarely a fatal condition.

5. The colored men are more susceptible, possibly because they keep up and about longer and come under treatment late. Their complaints may be disregarded by officers who think them shirking.

6. Leukocytes are not a reliable guide in determining the added streptococcus infection. Mononuclear increase is not a guide in determining serum temperature rise from septic temperature.

7. Protective streptococcus vaccination should be employed.

8. Diet: 2000 calories; 3000 c.c. of water should be administered daily.

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PROGRESS
OF
MEDICAL SCIENCE

MEDICINE

UNDER THE CHARGE OF

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Clinical Significance of the Abnormally Wide Ventricular Deviation in the Electrocardiogram.—NEUHOF (*Arch. Int. Med.*, July, 1918). The author has noticed in cases of myocardial disease (hypertension, aortitis, precordial distress, decompensation) that electrocardiographic tracings show an abnormal width of deviation of the *R* wave of the ventricular complex. Taking 0.07 of a second as the lower limit of abnormal he shows that all of his tracings with abnormally wide *R* presented unmistakable signs of myocarditis. "It had no relation to the height of the *R* wave, pulse rapidity, cardiac rhythm or to the underlying disease producing the myocarditis. In some of the cases severe decompensation was present; in others, absent. Though no definite statement of the fundamental cause of the abnormally long duration of the *R* phase can be offered, its frequent association with myocarditis would make it appear possible that this lesion acted as a direct hindrance to the proper, normal, rapid prolongation of the wave of electrical excitation through the ventricular musculature."

Studies on Renal Function during and Immediately Following Some of the Acute Infectious Diseases.—FROTHINGHAM (*Arch. Int. Med.*, July, 1918). Cases selected for this study were among young people who presented no urinary evidence of chronic or acute nephritis. The series included 6 cases of typhoid fever all on high caloric diet, 4 cases of pneumonia Group I (Cole), 6 cases of pneumonia Group IV (Cole),

5 cases of acute articular rheumatism and 6 miscellaneous cases (diphtheria, gonorrheal arthritis, periosteal abscess, acute gout). Renal function was studied during and just after the infection by (*a*) phenolsulphonephthalein test, (*b*) the estimation of blood urea and (*c*) the determination of McLean's index of urea excretion. The author concludes: "From these studies it may be concluded that these tests for renal function, namely, the phenolsulphonephthalein elimination, the urea nitrogen in the blood, and the index of urea elimination, failed to show consistent evidence of impaired renal function during the course of or following these acute infections in which the clinical picture or the urinary examination by the older methods showed nothing suggestive of acute nephritis."

SURGERY

UNDER THE CHARGE OF

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Pleural Infection in Wounds of the Chest; Pleurectomy for Old Suppuration with Pachypleuritis.—ROUX-BERGER and POLICARD (*Lyon Chirurgical*, 1917, xiv, 969) say that at the present time, wounds of the pleura and lung are more complicated than ever because of the serious infections from refraining from surgical aid altogether or from inadequate operations. In the treatment of lung wounds we must admit, as a fundamental basis, the theory generally accepted in war surgery: that these wounds are all infected; that it is easy to prevent infection by fully operating at once; that it may be extremely difficult to treat and sometimes impossible to cure an advanced pleuropulmonary infection. The treatment ought to be applied systematically to all chest wounds by shell splinters or bullets. It should be thorough and early and comprise the following stages: (1) A complete removal of the fractured rib, the infection of which, close to the pleura, is the chief cause of purulent pleurisy following these wounds. (2) A systematic extraction of the projectile whether it be in the pleura or in the lung, only very small projectiles or those situated very far from the opening may be disregarded. (3) The lung must be sewed up and the wound caused by the operation completely closed. Notice how restricted surgical aid on the lung is, for we cannot possibly remove all the bruised tissues. When this preventive treatment has not been applied we shall see pleuropulmonary lesions develop, clinically characterized by rapid cachexia and anatomically characterized by a noticeable thickening of the pleura, also by the constriction of the lung into a hard envelope and also by lesions in the lung of the acute bronchopneumonia type. The treatment of these deep-seated lesions is: (1) The removal of the infected fractured rib, which has been either totally neglected

or else wrongly treated. (2) The previous draining and disinfecting of the pleural cavity. (3) The removal (this as extended as possible) of the parietal pleura. (4) The decortication of the parietal and visceral pleura. In certain cases when the infection of the pleura does not extend to the top of the thoracic cavity the suppurating mass might be taken away whole. When these large pachypleural lesions have been taken away, the most serious obstacle to a cure will have been got rid of: but, the fresh cavity in the pleura will have to be constantly drained and must be looked upon as still infected.

Mixed Tumors of the Salivary Glands.—FRASER (*Surg., Gynec. and Obst.*, 1918, xxvii, 19) says that the mixed tumors arise from the ducts of adult glands. No claim is made that true neoplasm has been experimentally produced but the experimental results justify the conclusion that the primary structures of the mixed tumors may easily arise from the ducts of the adult gland. Facts established from the morphological study of 14 mixed tumors prove the point. The endothelial theory has no foundation in fact. All the so-called endothelial structures are easily explained as natural modifications of primary duct formations. Injury such as localized or partial obstruction of ducts probably plays a prominent part in the origin of these tumors. The most common precursor of cancer of the breast, chronic cystic mastitis or diffuse fibroadenomatosis, is a condition very similar to that which can be produced in the dog's submaxillary gland. Fraser has reproduced this condition with morphologically cancerous transformation in a series of experiments on the mammary glands of animals. The cartilage is developed from the epithelium of the parenchyma of the tumor.

Transfusion with Preserved Red Blood Cells.—ROBERTSON (*British Med. Jour.*, June 22, 1918, p. 691) describes in detail and gives the results of his method. There is a definite need in front area medical work of a method of giving transfusions rapidly. The difficulty of procuring sufficient blood under rush conditions, the time consumed in carrying out the transfusions, and the need of every available medical officer in the operating theatre, all tend to reduce the number of transfusions which can be given. The use of preserved human blood cells for transfusion suggested itself as a possible solution of certain of these difficulties. A quantity of blood sufficient for a number of transfusions could be stored up beforehand and used as needed. The technic of transfusing such blood is simple and could be handled by one medical officer. It is possible to preserve living human red blood cells for several weeks in a solution of dextrose and citrate when kept at ice-box temperature. This method has been made use of for giving transfusions at casualty clearing stations during a rush period. A quantity of blood was stored up beforehand ready for use when needed. The blood was kept for varying periods up to twenty-six days before transfusion. Twenty-two transfusions were given to twenty cases by this method, the majority of which were hemorrhages. The results were quite as striking as with blood freshly drawn. No apparent harmful effects were observed, as reactions or evidence of increased hemolysis after transfusion. Experiments in the transportation of preserved blood have shown that it can be carried a considerable distance without injury.

Abuse of Drainage Tubes.—Hathaway (*British Med. Jour.*, June 29, 1918, p. 718) says that as a result of our war experience wounds of the head, chest, abdomen (even with fecal contamination) and knee and other joints are sewed up with ampunity after early and complete operation, and the results are excellent. To replace a drainage tube all that is necessary is to put something into the tissues which will keep a "passage" open but which does not leave an open "drain." A soft piece of folded rubber, for instance, in an appendix abscess, will allow pus to come away but will not leave an open "drain" by which secondary infection of staphylococci, from the skin, or other organisms can gain entrance. The two main principles of civil surgery taught by the war are: (1) Early and complete operation, and (2) that secondary or mixed infection is worse than primary infection. In a severe case of pneumococcic empyema, Hathaway excised a piece of rib under a local anesthetic and made a small incision into the pleura. On emptying the pleura the cavity was washed out with flavine and about a pint of a suspension of iodoform in paraffin was injected, after which the wound was tightly closed by sutures. His general condition at once improved, the pulse and temperature gradually dropped and he made a better recovery, in all probability, than with an open "drainage tube." Hathaway concludes that in order to avoid mixed infections surgeons must practice primary suture far more than in the past, and completely give up the use of rigid open drainage tubes. If a secondary abscess or leakage from bowel should occur it will be dealt with by the inherent resistance of the body to infection, or should an abscess form it can be treated by a second operation, after adhesions have formed.

New Pathology of Syphilis.—Warthin (*Am. Jour. Syphilis*, 1918, ii, 425) says that the gumma is not the essential lesion of old or latent syphilis. It is a relatively rare formation and the great majority of cases of syphilis run their course without the formation of gummatous granulomata. The new pathology of syphilis is based upon the demonstration that the essential tissue lesion of either late or latent syphilis is an irritative or inflammatory process, usually mild in degree, characterized by lymphocytic and plasma-cell infiltrations in the stroma, particularly about the bloodvessels and lymphatics, slight tissue proliferations, eventually fibrosis and atrophy or degeneration of the parenchyma. These mild inflammatory reactions are due to the localizations in the tissues of relatively avirulent spirochetes. Syphilitic inflammations of this type occur in all tissues and organs, but are easily recognized in the nervous system, heart, aorta, pancreas, adrenals and testes. They are, however, usually widely distributed throughout the entire body, although in individual cases showing special predilection for certain organs or tissues. No explanation for these system, organ or tissue predilections is yet evident; neither is there any explanation of those cases in which all organs and tissues show the most severe degree of these lesions. The syphilitic is a spirochete carrier. In this respect the Spirocheta pallida is to be classed with the trypanosome, the malarial organisms, lepra and tubercle bacilli, streptococcus, etc. Syphilis tends to become a mild process, but at any time the partnership between the body and the spirochete may become disturbed and tissue susceptibility

or virulence of the spirochete become increased so that the disease again appears above the clinical horizon. Immunity in syphilis depends upon the carrying of the spirochete. A price is paid for this immunity in the form of the defensive inflammatory lesions previously described. The disastrous effects of syphilitic infection usually require a period of years for their development. The slow progressive lesions, fibrosis and atrophy, may at last manifest themselves in paresis, tabes, myocarditis, aortitis, aneurysm, diabetes, hepatitis or in many forms of tissue damage and functional disturbance. Lesions of the viscera are much more common and important clinically than those of the central nervous system, but they are rarely recognized as syphilitic by the clinician. Syphilitic death occurs most frequently in males between the ages of forty and sixty years. Chronic myocarditis is the most common form of death due to syphilis. The pathological diagnosis of syphilis is essentially microscopic. Only in a relatively small number of cases are the gross lesions (tabes, gumma, aortitis, etc.) typical enough to be recognized by the naked eye. A negative diagnosis of syphilis cannot be given with any certainty without a routine microscopic examination of all organs and tissues, but particularly of the left ventricle wall, the aorta, both its arch and abdominal portion, the testes, pancreas and adrenals.

Intravenous Injections of Sodium Iodide in Massive Doses in Obstinate Syphilis.—HOWARD (*Am. Jour. Syphilis*, 1918, ii, 550) bases his study upon a laryngeal case which received 125 massive doses of iodide, 54 salvarsan and many hundred intramuscular mercury injections. The indications for intravenous iodide treatment are as follows: Whenever the full iodide effect is required; when iodism develops before the desired result is obtained, iodide may be continued intravenously; in unconscious patients or those unable to swallow; in late internal syphilis, tabes, paresis, cirrhosis of the liver, aortitis, etc.; when mouth medication fails to be effective and symptoms progress. It is doubtful if there are any contraindications except lack of positive indications. He concludes that sodium iodide intravenously is harmless, and undoubtedly superior to both the potassium and the sodium salt given by the mouth. It contains relatively more iodin than the potassium salt. Sodium iodide can be given in much larger doses than the corresponding potassium salt and is not depressing to the heart muscle, as is the case with the potassium iodide. It is better tolerated intravenously than by mouth and can be given in larger doses. The treatment is administered daily. Patients often prefer the intravenous mode of administration. A solution of from 5 to 10 per cent. strength is correct and its injection painless. No reaction appears until large doses are reached and iodism is rare. Intravenous dosage is 10 to 335 grams. Chills started at 225 grains and have been reported by no other observer.

Gunshot Wounds of the Peripheral Nerves.—NOON (*Lancet*, July 27, 1918, 100) between June, 1915, and March, 1918, observed 250 cases in the Norfolk War Hospital. He concludes that the diagnosis of an injury to a peripheral nerve ought to be made at the earliest possible time; successful recovery depends upon early, correct and continuous

treatment; primary suture should be considered and practised whenever possible; that there should be no unnecessary delay in exploring a nerve if there is sufficient evidence that it has received some injury resulting in a macroscopic pathological lesion; it is almost certain that some macroscopic lesion is present in cases which show no signs of recovery after four months' treatment; that operations on injured nerves should only be done in well-equipped general hospitals and by those surgeons who have ample experience of such cases; that sufficient attention is not paid, usually to the early preoperative and postoperative treatment and that paralytic deformities and shortened muscles are often the result of ignorance and neglect; that the extreme gravity of an injury to a peripheral nerve is not sufficiently realized by the general practitioner.

Empyema in Base Hospitals.—The Surgeon-General's Office (*Review of War Surgery and Medicine*, August, 1918, No. 6, i, 1) reports the results of a study of empyema in base hospitals by a commission appointed for the purpose. The commission reached the following conclusions: An exudative pleuritis is a relatively frequent complication of bronchopneumonia associated with hemolytic streptococci. The evidence that this complication is an example of selective invasion of serous membranes by this organism is defective. The involvement of the pleura is probably an extension of the infection from the lungs, often through the medium of a subpleural pulmonary abscess. During the early stages of the pleuropneumonic process the pleuritis is probably of far less import than the pulmonary condition and general toxemia. The evacuation of the pleural exudate by operation early in the disease involves greater risks, without compensating benefits, than the removal by aspiration. Much of the relief offered by operation without its attendant dangers can be offered by aspiration, repeated according to indications. The condition of the patient at this time calls for medical rather than surgical treatment. The results of further immunological studies may offer a mode of treatment particularly applicable to the early phases of infection with the hemolytic streptococcus. At present there is little or no evidence that available sera are useful. In the early stages of this pleuritic infection the exudate is serofibrinous, the amount of serum being often very large. Later, the exudate becomes progressively more purulent and eventually is a frank, creamy pus. If treatment by aspiration is continued thereafter this pus may become sterile, as has been observed in one case. But this should be regarded only as an unusual occurrence and for a rapid convalescence an operation for its removal and access to the cavity for drainage and antiseptic treatment is called for. Three of the cases, however, have recovered, with repeated aspirations, without the necessity of operation. But in none of these had frank pus formed by the time of the last aspiration. During the period in which the above changes in the pleural fluid are taking place the general condition of the patient usually improves and operative interference is attended with comparatively little risk and much benefit. The operation should be preceded by a fluoroscopic examination to fix upon the most favorable site for the incision. Local anesthesia suffices and is preferable to a general anesthetic. The drainage of the empyemic

cavity should be both complete and continuous. Antiseptic treatment of the cavity should be instituted as promptly and thoroughly as conditions permit. In cases not complicated by bronchial communications with the empyema cavity a neutral solution of sodium hypochlorite, 0.5 per cent. (Dakin's solution), may be used effectively in cleansing and disinfecting the cavity. In recent cases, with free access to all parts of the cavity, dichloramin-T, 5 per cent., dissolved in chlorcosane, may be substituted for Dakin's solution; but if there is a thick fibrinous deposit upon the pleural surfaces this is less readily removed and drainage more difficult to maintain than when Dakin's solution is employed. In applying chlorin antiseptics (Dakin's solution or a chlorcosane solution of dichloramin-T) the following conditions should receive attention: free drainage; contact of the solution with all parts of the cavity, which is best attained by the use of Carrel tubes; adequate quantities of the solution must be used with sufficient frequency to maintain its action over the period of time necessary for disinfection; the progress of disinfection may be followed by bacteriological examination of the discharges; when the empyemic cavity has become cleansed beyond the point characterized by a viscid secretion from the wound there is usually evidence of increased freedom for expansion of the lung; the danger of such cicatricial fixation of a compressed lung is an indication for prompt operation and cleansing of the empyemic cavity after the acute stages of the disease have passed; expansion of the lung can be encouraged and perhaps accelerated by various procedures, such as (1) blowing against resistance; (2) the use of negative pressure and gentle suction devices; (3) properly controlled exercises which induce not only a more active metabolism but also more active breathing; the influence of such measures can be directly observed, but unless they can be maintained over a period at least long enough for agglutination between the surfaces to take place it is doubtful whether they materially hasten obliteration of the pleural cavity. For roentgen-ray examination of old cavities with fistulas it has been found that the thorium nitrate in 10 and 15 per cent. solution is satisfactory; its advantages over pastes of various kinds are its ease of introduction and of withdrawal.

THERAPEUTICS

UNDER THE CHARGE OF

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Etiology and Treatment of Pruritus Ani.—Out of 181 cases of pruritus ani examined, MURRAY (*Jour. Am. Med. Assn.*, 1918, lxxi, 1449) found Streptococcus fecalis present in 168. Examination of the blood of every patient showed that the coefficient of extinction of opsonins for Streptococcus fecalis was low, while in patients suffering from rectal

diseases without pruritus it was normal. Whether the infection occurred because of the low opsonic index or whether the opsonins were lessened because of the invading organism was not determined. Murray treated these cases by means of an autogenous vaccine. Of 113 cases treated in this manner, distinct relief was obtained in 99. Thirteen patients received little or no benefit, but only 4 of these received a sufficient number of treatments. Murray concludes that pruritus ani is caused by an infection by one of the streptococcus group or associated with it. This infection may be primary, secondary or the aggravating cause. Statistics of 4000 distinctly rectal cases show that only about 10 per cent. had pruritus ani, which is, he thinks, sufficient evidence that the appearance of pruritus in these conditions is merely coincidental. Murray believes that pruritus ani will not be improved by operative measures unless the phagocytic power of the blood be increased, and states that a relapse may be expected if the opsonic index of the blood is again lowered enough to allow a reinfection.

Treatment of Influenza Pneumonia by the Use of Convalescent Human Serum.—McGuire and Redden (*Jour. Am. Med. Assn.*, 1918, lxxi, 1311) found the mortality from pneumonia following influenza at first as high as 50 to 60 per cent.; later dropped to 30 per cent. Over 400 cases were treated at this naval hospital. Thirty-seven cases in all were treated by serum. Of these, 1 died, 30 are convalescent and 6 are still under treatment, all but 1 of whom have a favorable outlook. The serum was obtained from convalescent patients. The most beneficial results were obtained when the serum was given within the first forty-eight hours of the pneumonia complication. The dose of serum administered was from 75 to 125 c.c. intravenously, the majority of patients receiving about 300 c.c. The treatment was continued until there was no doubt about the recovery of the patient. If results from a serum were not obtained in the first twenty-four hours after its use the serum from another donor was used. Persistent attempts were made to test the potency of the serum of the donors by complement-fixation and by gross agglutination, using the influenza bacillus as an antigen; but so far the writers have found no method of testing the antibody content of the serum except by its clinical action. They conclude that, even making allowance for the lessened virulence of the organism at the time of observation, the serum from convalescent influenza pneumonia patients has a decided influence in shortening the course of the disease and in lowering the mortality.

Serum Treatment of Type I Pneumonia Occurring in Association with an Epidemic of Influenza.—During the epidemic of influenza at Camp Devens, pneumonia clinically atypical from the classical acute lobar pneumonia became very prevalent. A small number of these were demonstrated to be due to Bacillus influenzæ alone. Of the patients showing clinical signs of pneumonia the usual percentage (20 per cent.) of Type I pneumococcus was demonstrated in the sputum. Spooner, Sellards and Wyman (*Jour. Am. Med. Assn.*, 1918, lxxi, 1310) report briefly the effect of Type I serum in these cases. Before the epidemic, serum of low titer was used in the treatment of typical

Type I lobar pneumonias. In this group there was a mortality of 20 per cent. During the epidemic, with essentially the same treatment, there was a mortality of 43 per cent. At the height of the epidemic a supply of high titer serum was obtained. This was administered to 15 patients, 14 of whom recovered—a mortality of 7 per cent. The patient who died was in an extremely critical condition at the time of administration of the serum. An unusually high mortality (50 per cent.) in Type II cases of pneumonia was found during the influenza epidemic. The writers conclude that it is inadvisable to inject pneumonia patients with large quantities of low-grade serum.

The Rat and Poliomyelitis.—From the experiments here reported, AMOSS and HASELBAUER (*Jour. Exp. Med.*, 1918, xxviii, 429) conclude that it is improbable that the rat acts in nature as the reservoir of the virus of poliomyelitis.

OBSTETRICS

UNDER THE CHARGE OF

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Cesarean Section for Eclampsia.—INGRAM (*Am. Jour. Obst.*, June, 1918) reports the case of a patient weighing about 200 pounds admitted to the hospital in convulsions and semicomatose. She was a primipara, aged thirty years. On vaginal examination the cervix was long and firm, the vagina very long and small, so that the presenting part could be felt with difficulty. During one and a half hours after admission she had five severe convulsions, and Cesarean section was immediately performed. It was found that the patient had twins. Both children were dead at delivery. The patient's convulsions ceased at the operation, but on the tenth day the patient suddenly became cyanosed and died. Autopsy gave no information as to the cause of death; there were no signs of infection, but there was a large quantity of serous fluid throughout the peritoneal cavity. His second case was thirty-nine years of age, a primipara, a very large women, having a blood-pressure of 160 systolic. Internal examination showed a very long, firm, conical cervix, with no dilatation. The patient had four severe convulsions in the two hours following admission. At section the abdominal wall was very thick and boggy and there was a large quantity of fluid in the peritoneal cavity. The operation proceeded without special difficulty, but on the following morning the patient had a convulsion and also one in the evening. She steadily improved, and six days after operation the urine showed a very faint trace of albumin. The abdominal wall broke down and the wound did not unite; under anesthesia the edges of the wound were freshened by rubbing with a hot abdominal pack and silkworm-gut sutures were introduced, and ultimately she made a good recovery, with an excellent abdominal scar.

Cesarean Section in Twin Pregnancy, with Unusual Complication.—CONWAY (*Am. Jour. Obst.*, June, 1918) reports the case of a primipara, aged forty-one and a half years, who had good general health, but during the last two months of pregnancy suffered considerable pain over the whole abdomen and marked constipation, with loss of appetite. For a week prior to admission to the hospital she was ill with peritonitis. On examination there was slight albuminuria and a positive Wassermann reaction. Pelvic measurements were practically normal. Pain had begun twenty-four hours before admission, and had lasted forty-eight hours, with but little progress. An attempt was then made to dilate and deliver by forceps under an anesthetic, but the cervix could not be dilated. After the patient had had irregular uterine contractions without progress for three days she was operated upon by section. On opening the abdomen the uterus was very large and adherent to the peritoneum, a child, weighing 6¼ pounds, and a placenta, adherent and thrombosed in many places, were delivered; a second child was rapidly delivered, with a normal placenta. Although the first child was asphyxiated at birth it was revived. The appendix was postcecal and embedded in an inflammatory mass. There was no gangrene and no free pus, but unquestionably the peritonitis originated in the appendix. The patient was stimulated freely and reacted slowly. Her convalescence was complicated by chills and excessive sweats and bad action of the heart. Pus formed and gravitated to the cul-de-sac, when it was easily removed by vaginal puncture and drainage. The patient then improved rapidly and mother and two children left the hospital in good condition.

Spontaneous Evolution of a Transverse Presentation.—MOUNT (*Am. Jour. Obst.*, June, 1918) reports the case of a negro multipara who in previous labors had escaped complications. There had been slight pain for two days, which increased considerably, and the doctor in attendance had diagnosticated breech presentation. Very hard pain developed during the second stage, bleeding became less and the placenta was not felt; the cord prolapsed and ceased to pulsate. The fetal heart could not be heard at any time. The presenting part by vaginal examination could not be identified. In the midst of a hard pain the patient spontaneously expelled the child and placenta. The child was stillborn, slightly macerated and weighed 3 pounds 15 ounces. When the child appeared it was apparently in transverse position, shoulder presentation. These cases are possible only when the pelvis is of ample size, the patient a multipara and expulsive pains exceedingly strong.

Mortality among Women from Causes Incidental to Childbearing.—DUBLIN (*Am. Jour. Obst.*, July, 1918) contributes a paper upon this subject, based upon his experience in the Metropolitan Life Insurance Company of New York. The time was a period of six years, 1911 to 1916, and 14,694,260 women had been insured. These were between the age of fifteen and forty-four years, and included negro women as well as white, living in nearly all the States of the Union and Provinces of Canada. Most of these were women who worked, many of them foreign-born, among whom the birth-rate is usually somewhat higher

than among the native population. These women had, however, a well-organized visiting nurse service who cared for them during and after confinement. This material was valuable for study because the statistics were carefully made. The women were those greatly influenced by economical conditions, and one could trace among them the beneficial effect of the trained nursing service. In studying this problem the specific death-rates were limited to females of childbearing ages, fifteen to forty-four years. The statistics were made up for five- and ten-year periods, and the death-rates are thus based on death and life-rates homogeneous, with respect to sex and age. In 10,056 deaths from disease and conditions incidental to childbirth were found between the age of fifteen and forty-four years, and these occurred in the six-year-period. This gives a death-rate of 68.4 for each 100,000 women. Of these deaths, 8288 occurred among white women and 1768 among colored, the rate per 100,000 being 66.1 for the whites and 82.3 for negroes. Among these 10,056 deaths were 4321 from septicemia; 43 per cent. of the total deaths, next in importance, was albuminuria and convulsions, 2654 deaths or 26.4 per cent. of the whole. These two conditions accounted for 69.4 per cent. of the puerperal cases, but the actual proportion is even higher; this arises from the fact that many of these cases are not accurately reported. On examination the mortality rate of the white and negro races it is found that the mortality-rate from septicemia in the whites is 27.9 and in the negroes 38.5 for 100,000. The mortality-rate for puerperal hemorrhage is slightly lower for negro women, and this is true of other puerperal diseases and conditions. When the question of age is considered the least deaths occur from all diseases and conditions incidental to childbirth among white women between fifteen and nineteen years, namely, 24.3 in 100,000; this rate rises rapidly to 93 between twenty-five and thirty-four years and then falls to 62.2 from thirty-five to forty-four years. Among negroes between the age of fifteen and nineteen years the rate is 93.4 for 100,000, the same practically as that among the whites of twenty-five and thirty-four years. In general, while among the negro the maternal mortality is four times that of the whites between fifteen and nineteen years and more than one-quarter greater between twenty and twenty-four years, for the age after twenty-five and up to forty-four years the mortality-rates of negro females from puerperal conditions are lower than the rates for the whites. As regards puerperal septicemia its highest mortality is between twenty-five and thirty-four years and its lowest rate between fifteen and nineteen years among white women; among negroes there is a high rate between fifteen and twenty-four years, with very little decline between twenty-five and thirty-four years; from thirty-five to forty-four years the rates for whites and negro women are practically the same. Albuminuria and convulsions are least fatal among white women between fifteen and nineteen years and the maximum of 22.6 between the age of twenty and thirty-four years. Negroes show a maximum rate between fifteen and nineteen years of 36.9 for 100,000, with a gradual decline to forty-four years to 13. In the accidents of pregnancy a very large proportion of the fatal cases are due to attempts at abortion. Among white women the death-rate from all accidents in pregnancy is comparatively low until twenty-five years is reached; the highest rate 8.7 per 100,000 is found between the age of twenty-five and thirty-four

years. Negro women have a higher accident rate than white, especially under the age of twenty-five years; between twenty and twenty-four years the negro death-rate is 10.3, or more than twice that of the whites. Puerperal hemorrhage includes placenta previa and retained membranes provided there is no question of septic infection. The mortality-rate is least in the youngest ages among the whites and reaches the highest between twenty-five and thirty-four years, 8.1 per 1000. Among negroes it is highest between twenty-five and thirty-four years. Negro women suffer from puerperal hemorrhage much less frequently than the whites. So far as the mortality-rate in parturition is concerned, in the accidents of labor between fifteen and nineteen years among negroes the rate is five times that of the whites. Among white women most fatal accidents occur between the age of twenty-five and thirty-four years, 1.4 per 100,000, while among negroes it is earlier. It is significant to know that at the present time there is one maternal death in every 100 to 200 cases of pregnancy and childbirth; this, however, is a result obtained by studying large centers of population and the risk of maternity is second to only that of pulmonary tuberculosis; the importance of prenatal work therefore becomes evident. The value of conservation is seen in the fact that in 1916 nurses employed in caring for maternity cases made 243,738 visits. Study of statistics show definitely a very marked lessening in maternal mortality and morbidity following the work of the visiting nurses.

Cesarean Section for Contracted Pelvis, Double Uterus and Multiple Fibroids.—YOUNG (*Am. Jour. Obst.*, July, 1918) reports the case of a patient, aged twenty-eight years, six months pregnant. On examination two vaginas were found and both cervices. Abdominal examination showed a six months' pregnancy, with marked enlargement on the right side. The pelvic measurements indicated a markedly contracted pelvis, and the symphysis was distinctly bent. An elective operation was chosen and the patient kept under observation. In the eighth month the patient went into labor and a foot protruded from the vagina; the fetal heart sounds were not heard. The patient was at once subjected to operation, when the two uteri were found blended, with small fibroids in the right fundus; there were two tubes and two ovaries. Uterine incision was made vertically as near the middle line as possible from the right uterus a female child was delivered alive. The mass which had been mistaken for the fetal head was found to be a pedunculated fibroid attached to the lower portion of the posterior wall of the uterus. Supravaginal hysterectomy was performed, leaving the left ovary. The patient's recovery was complicated by infection of the lower third of the wound and by a lobar pneumonia, from which she recovered after severe illness. She finally did well and the incision healed completely; the septum between the two vaginas disappeared; there was a ridge on the anterior and posterior wall of the vagina showing where the septum had been; both cervices were still present.

Nitrous Oxide Oxygen Analgesia in Normal Labor and Obstetric Operations.—DANFORTH (*Jour. Am. Med. Assn.*, July 6, 1918) has observed 663 cases, and he finds that in relieving the pain of labor it is important to administer the gas before uterine contractions become

apparent to the patient. The patient breathes in the gas three or four times, occasionally six to ten depending on the relief afforded. It is occasionally necessary to give the gas throughout the entire duration of a pain. During the second stage the obstetrician must inform the person giving the anesthetic as soon as the pain begins, so that the gas may be begun soon enough. Gas alone is only of advantage when a few breaths are sufficient; if this is not the case, 5 to 15 per cent. of oxygen should be added. While the child is in the uterus rebreathing is not used. The operator must avoid cyanosis and the patient should not be completely anesthetized, because it is desirable to retain her coöperation. During the final pain of delivery it is well to add ether, which gives, as a rule, no unpleasant effects. Ether will secure the needed relaxation, and if obstetrical operation is to be performed its use is urged. In 93 per cent. of the cases recorded, analgesia by nitrous oxide oxygen has been satisfactory. For the minor operations of obstetrics, such as repair of the perineum, episiotomy and other such manipulations, gas oxygen is an excellent agent provided it be given by skilled anesthetists.

Problems of Social Order in the Interest of Mother and Child.—The *Arch. mensuelles d'obst. et de gynec.* contains a series of articles upon the needs for caring for the pregnant and nursing women who are working for the country, preventing criminal operations and an account of the midwife service now prevailing in France. The first article, that of protecting pregnant and nursing women working in industries, contains an account of various hygienic methods, including the limitation of the hours of work and diagrams showing rooms adapted for nursing mothers, and brings out forcibly the fact that nursing a child must not be made to a woman engaged in work a burden of fatigue, nor must it be a cause for the loss of money. A nursing mother must reduce the amount of work which she is doing, and as this will lessen her wage it is the duty of the State to make this good by some form of indemnity. This can only be brought about by the appointment of an agent or patron who will assume the supervision of each group of nursing mothers. Those who have undertaken this study await with great interest the results of the entrance of the United States into the war as to whether this will reduce somewhat the strain upon the foreign nations. In comparing the years of the war it is found that stillborn infants in the year preceding the war were 7.69 for 100; in the first year of the war 6.63 for 100 and in the second year of the war 7.67 for 100. In the year before the war 3 children in each 100 were sent away from Paris to be cared for; during the first year of the war this rose to 13.35 for each 100 and during the second year to 22.32 for each 100. In the year before the war 4.98 infants were abandoned by their mothers; this number fell during the first year to 2.88 for each 100 and during the second year 5.25 for each 100. The result of the war is shown in the condition of children born before the war and during the war; thus in the year preceding the war in 100 cases 33.43 were brought to full term, while during the first year of the war 56.40 were brought to term and during the second year of the war 54.76. It is surprising to note that there has been an actual lessening in premature births since the war began; thus in the year preceding the outbreak the percentage of premature births was 66.7, which dropped

to 43.60 in the first year of the war and to 45.25 in the second. During the first two years of the war newborn children weighed distinctly more than in the year preceding the outbreak of the conflict and the number of children deficient in weight diminished during the first two years. So the mortality from puerperal diseases dropped from 0.67 for 100 to 0.46 in the first year of the war and 0.48 in the second. Several explanations may be given for this condition of affairs, one that mothers received more care than previously and another that a feeling of patriotism induced them to care for themselves and their offspring. Different European countries have different laws concerning the employment of pregnant and nursing women in various forms of industry, and in each case these laws must be made to meet local conditions. In France it has been proposed to give to each mother nursing an infant 20 francs a month as an aid in her support. Scarcely less important than the care of pregnant and nursing mothers is the prevention of criminal abortion. This may be done in several ways: by the establishment of secret or confidential maternity centers which will care for all pregnant women without asking their identity; by special hospital wards for pregnant patients where women at all stages of pregnancy can receive admission; by police regulations against the production of abortion and employment of means to prevent conception and by the aid of the medical profession in the exercise of their influence in this important matter. The situation of the midwife in France also receives attention and maps are produced showing the relative number in different portions of the country and certain reforms are outlined to increase the efficiency and standing of midwives. For this purpose it is necessary to limit the number authorized to exercise the rights of their profession and to redistrict the country with reference to the number of births occurring in each locality. It is also essential to exercise a proper supervision over infants in nursing-homes or wet-nurses and to consult with wet-nurses and those having homes for infants. The midwife must be assured an honorable life by the payment of sufficient indemnity to enable her to live decently and lay aside something for old age. Every five years midwives should serve in an obstetric clinic or a maternity hospital having a medical faculty for at least fifteen days in order to prove their ability and to learn whatever advances in obstetrics may have been discovered. Furthermore, the professional obligation of midwives should be very clearly defined and also their rights in the matter of compensation and the conditions under which they are to live in private houses.

Tetanus Neonatorum.—Robles (*Nederl. Tijdschr. v. Geneeskunde*, Amsterdam) reports 3 severe cases of tetanus neonatorum, of whom 1 died and 2 recovered. He used narcotics, such as chloral, ether, chloroform and morphin freely. These substances seemed to have a direct action in the toxins produced in tetanus as well as their quieting effect upon the nervous system. It was also useful to put these infants in incubators in a dark room, as this protected them against disturbance and irritation of every kind. The infants were nine, thirteen and fifteen days old, and on several occasions 120 units of antitetanus serum was injected. The incubation period seemed to be eight, ten and eleven days Recovery from tetanus in newborn infants is exceedingly rare.

HYGIENE AND PUBLIC HEALTH

UNDER THE CHARGE OF

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Bacteria of Gangrenous Wounds.—MAJOR H. R. DEAN and CAPTAIN T. B. MOUAT (*British Med. Jour.*) report that the cases which provided material for this investigation were selected from those undergoing treatment at the third Northern Hospital, Sheffield. In nearly all there was evidence of the presence of necrotic or gangrenous tissue in the wound, but few presented the clinical features of emhysematous gangrene. From fragments of necrotic tissue or of the discharges from the deeper parts of the wound, smears were made on blood-agar and, in some cases, on MacConkey's medium to identify aërobic organisms. To isolate and identify anaërobic organisms a tube containing about 5 c.c. of broth was heavily inoculated with the material to be examined. An egg broth was employed in several instances in place of the regular broth. Glucose agar was found to be most suitable for anaërobic plate cultures. Cultures were also made on Dorsett's egg medium. The following table shows the results of 18 cases under observation.

No. of cases.	Gas observed in tissues.	Symptoms of tetanus.	Fatal.	B. edematis maligni.	B. aërogenes capsulatus.	B. tetanus
1	0	+	0	+	+	0
2	+	0	+	+	+	0
3	0	0	0	+	+	0
4	0	0	0	0	0	0
5	0	0	0	+	0	0
6	0	+	0	+	0	+
7	0	0	0	+	0	0
8	0	0	0	+	+	0
9	0	0	0	+	+	0
10	0	0	0	+	+	+
11	0	0	0	+	+	0
12	0	0	0	+	+	0
13	0	0	0	+	+	0
14	+	0	0	+	+	+
15	0	+	0	+	+	0
16	0	+	+	0	+	+
17	+	0	+	+	0	0
18	+	0	0	+	+	0

Streptococci were isolated from nearly all the cases and seemed to be of one type. Staphylococci were isolated less frequently than might have been expected and, when present, they were usually not

numerous. B. coli was isolated from 4 cases and a proteus bacillus from Case No. 5. Of the three anaërobic bacteria present, B. aërogenes capsulatus and B. edematis maligni differ greatly in shape and in staining reaction under different cultural conditions and therefore, the identification from a smear alone may be difficult. The nature of the culture medium and the age of the culture affect the results of the Gram method of staining and also the formation of spores. The different varieties showed different rates of growth. After two or three days' incubation the broth may appear to contain a pure culture of B. aërogenes capsulatus and after further incubation, B. edematis maligni is often the predominant organism. Tetanus bacilli may not appear until after ten days' incubation. The cultural characteristics of the various strains were examined on agar, glucose agar, broth, litmus milk and Dorsett's egg medium and the reactions produced with various sugars and alcohols were recorded. A pure culture of B. edematis maligni was isolated in 15 cases, all of which were cases in which considerable laceration and necrosis of tissue had occurred. Only 3 of these cases were fatal, and of these, 1 showed a large gas-containing abscess, 1 was a case of tetanus, and the other showed complications. There is, therefore, no reason apparently to think that the presence of this microörganism in a wound is of serious import. The cultures isolated showed typical staining and cultural characteristics. B. aërogenes capsulatus was isolated from 13 of the 18 cases, but of these only 2 were fatal, death in this instance being due to tetanus. The morphology, staining and cultural characteristics of this bacillus were all typical. By a series of animal inoculations with B. aërogenes capsulatus and B. edematis it was shown that these organisms are not necessarily associated with the development of gas in tissues. They are essentially saprophytic, growing rapidly in dead tissue and producing poisons which invade the adjacent living tissue and render it a suitable medium for their growth by destroying it. The examination of films from the discharge from the wounds in the six cases, Nos. 1, 6, 10, 14, 15 and 16 of tetanus, showed no bacteriological forms resembling tetanus, but in the films made from mixed broth cultures, tetanus forms were observed in 5 cases, but only after long incubation periods. In Cases 6, 10, 14 and 16 the presence of tetanus was determined by animal inoculation with the original broth culture, and in one of these cases a pure culture of tetanus was isolated. The cultural characteristics were tested and found typical. Out of 11 guinea-pigs and 2 rabbits, which were inoculated from a ten-day-old broth culture of this strain, only 4 of the pigs succumbed. B. tetani were found in the discharge from the wounds of 2 patients who did not develop signs of tetanus and who had received prophylactic injections of antitetanus serum. The other 4 patients who showed signs of tetanus had had no antitoxin. The presence of B. tetanus is difficult to demonstrate bacteriologically and the patient may develop tetanus before a diagnosis has been pronounced. The presence of B. aërogenes capsulatus or B. edematis maligni might be taken as an indication for one or more prophylactic injections of antitoxin, which should also be injected before any operation on a patient with a gangrenous wound.

Combined Preventive Inoculation against Typhoid and Paratyphoid Fever and Bacillary Dysentery.—J. Pratt Johnson and A. J. Milne (*British Med. Jour.*, January 15, 1916) state that the use of mixed bac terial vaccines has been shown to have a sound experimental and clinical basis, and great success has followed their use. The authors have investigated the possibility of combined preventive inoculation against typhoid and paratyphoid with that against dysentery. The great toxicity of B. dysentery offered a serious difficulty in the use of dysentery vaccine. This was overcome by employing the method of Broughton-Alcock (*British Med. Jour.*, August 8, 1914), which consisted of the use of a dysentery vaccine completely sensitized with a heated polyvalent dysentery serum. The vaccine prepared contains the Shiga, Flexner, Krause, Hiss and Russell strains in equal proportions, and 50 inoculations were carried out. A few inoculations were conducted with varying doses of untreated dysentery vaccine. Conclusions: (1) Inoculations with untreated dysentery are impossible, owing to the severity and duration of the local reaction. (2) Complete sensitization of dysentery vaccine produces marked reduction in local reaction. (3) The use of a typhoid and paratyphoid vaccine combined with sensitized dysentery vaccine can be employed in doses sufficiently large to produce a satisfactory immunity while the local reaction is, in all cases, slight. Such a vaccine should contain 1 c.c. of B. typhosus, B. paratyphosus A and B, 500,000,000 in a ratio of 2, 1, 1 plus B dysentery (sensitized), 250,000,000. A dose of 1 c.c. is recommended as a first inoculation followed by a second inoculation of the same amount after seven or eight days. The injections should be made in subcutaneous tissue over muscle. (4) After one inoculation of a combined untreated vaccine, specific agglutinins are found in the blood after an interval of nine to fourteen days for each of the organisms present. Immunity, therefore, is rapidly produced.

Methods of Destroying Lice.—In view of the fact that typhus fever is conveyed by the louse the control of this insect is a matter of public health importance. Kinnoch (*British Med. Jour.*, 1915) found that heat is more effective than moist heat in destroying lice and other insects. The louse can be revived after immersion for one minute in other insects. The louse can be revived after immersion for one minute in water at 100° C. Exposure to dry heat at the same temperature, and for the same time, appears to kill both lice and nits. The paraffin bodies are actively insecticidal, and of these gasoline is the most effective. Lice and their eggs are destroyed by immersion in gasoline for one minute and they may be killed by exposure to the vapor of gasoline for half an hour. Powerful fatty solvents, such as benzine, toluene and acetone, are just as toxic to lice as gasoline. Certain chlorin derivatives of methane, ethane and ethylene are more lethal to lice than any other substances and have the important merit of being non-inflammable. Immersion in the chlorin derivatives of ethane and ethylene immediately destroys all lice and nits and exposure to the vapor of these substances for five minutes is equally destructive. Even soap solutions containing 2 per cent. of trichlorethylene or 10 per cent. of tetrachlorethane are capable of killing in half an hour at the ordinary

temperatures all lice and nits. A 25 per cent. solution of dichlorethylene or trichlorethylene in vaseline when applied to the human body has been found capable of exerting its insecticidal action for hours. A 25 per cent. solution of gasoline in vaseline is of shorter duration, but is effective for some hours. The common phenol disinfectants fail to kill lice or nits at ordinary temperature. The volatile oils have no direct insecticidal effect. The human body anointed with sulphur, balsam of Peru, mercury ointment and hellebore ointment do not prevent the hungry louse from feeding. For practical purposes it has been found that the destruction of lice and nits is best secured by immersion of garments and body clothes in a gasoline or benzine bath. Danger from fire and waste of gasoline are avoided by using such a bath and extractor as are employed in a dry-cleaning apparatus. For personal prophylaxis it seems certain that lice would not continue on the human body if anointed daily with a 25 per cent. solution of trichlorethylene in vaseline or on the body anointed twice daily with a solution of gasoline in vaseline of similar strength.

Production of Antipneumococcus Serum.—Cole and Moore (*Jour. Exp. Med.*, October 1, 1917) state that in the production of immune serum for therapeutic purposes strict attention must be paid to the immunological specificity of the bacteria used for immunization. At present the only serum of which the therapeutic value has been proved is that effective against Type I pneumococcus infection. This serum should have agglutinating power for Type I pneumococcus and should have the power of protecting mice against large amounts of virulent culture. Experiments have shown that for producing the primary immunity most rapidly several series of small doses of dead cultures should be given, the injections being made daily for six or seven days, followed by a week in which no injections are made. To produce the highest type of immunity probably living organisms are required. These should be given in moderate doses daily for three days with an interval of a week between each series of injections. By following accurately the methods described, horses may be made to produce rapidly a high grade of specific serum. The observations so far made indicate the importance of employing small doses of culture frequently repeated in this form of immunization.

Suggestions Concerning the Prevention and Cure of Acute Lobar Pneumonia.—Cole (*Am. Jour. Pub. Health*, June, 1917, vii, No. 6) reports briefly some of the late observations and conceptions concerning prevention and cure of acute lobar pneumonia and includes a résumé of some work done at the hospital of the Rockefeller Institute. He emphasizes the fact that over half the cases of acute lobar pneumonia occur between the ages of twenty and fifty years, the period of greatest activity. Many laymen and physicians are prone to regard pneumonia as a disease of the very young and the aged. About 65 per cent. of the cases of acute lobar pneumonia are caused by pneumococci of Types I and II, types which are immunologically quite distinct and have definite, specific characters. The mortality rate among cases infected by these organisms is 25 to 35 per cent. A third type of organism

causes pneumonia in only about 10 per cent. of the cases. Most of the pneumococci found in mouths during health belong to Type IV. Of 942 normal individuals studied in the hospital of the Rockefeller Institute, 450 or 47 per cent., were found to harbor pneumococci, and group IV claimed 345 out of the total. Types I and II appeared in 56 instances. In all but 3 of the cases in which Types I or II were isolated from normal individuals the healthy individuals had been in close association with a person sick of pneumonia caused by the same type of pneumococcus. In studying the length of time convalescents or healthy carriers might harbor organisms belonging to Types I or II it was found that in most cases the organisms belonging to these types die out in the mouths of convalescents within a few weeks. The longest time in which any organisms have been observed in the mouth of a convalescent has been eighty-three days. The same facts hold good concerning the persistence of Types I and II in the mouths of healthy carriers. Study of dust in houses where pneumonia was present and in houses where no known cases of pneumonia had occurred showed the following interesting results: From 175 specimens of dust from houses which had contained pneumonia due to Type I or II, 73 specimens showed pneumococci, and of this number 47 belonged to Types I or II. In only 2 cases did the type of pneumococcus found in the dust fail to correspond with the type isolated from the patient. Sixty-two specimens of dust from houses where no cases of pneumonia were known to have existed were studied. Of these specimens 18 showed pneumococcus and only 1 was of Type I or II and in this case the known carrier of the corresponding fixed type was found to be visiting at the time. Infections from Type III, which causes the most severe pneumonia, are somewhat baffling in the effort to discover their source. In an examination of 450 healthy carriers, group III appeared 85 times, and in practically none of these persons could any association with cases of pneumonia due to the same type of organism be discovered. It has been proved that these healthy carriers may harbor group III organisms even for years, and as yet no difference of any character has been found between the Type III organisms found in disease and those found in the mouths of healthy carriers. With reference to preventive inoculation the author appears to think that among troops preventive inoculation might be tried with considerable hope of success, although the results of its use in civil population hitherto have been disappointing. The author recommends in conclusion: (1) That pneumonia be made a reportable disease; (2) that patients be isolated, sputum sterilized and that the rooms occupied by pneumonia patients be thoroughly cleansed at least with soap and water (if not disinfected); (3) that for statistical purposes health departments should determine the type of pneumococci in pneumonia cases; and (4) that utmost speed be exercised in identification of the type of pneumococcus in a given case when it is intended to employ serum treatment, the greatest benefit being obtained by the earliest possible administration of the serum in appropriate cases.

Bacteriology of the Bubble Fountain.—PETTIGONE, BOGART and CLARK (*Jour. Bact.*, 1916, No. 5, i) reported the results of an investigation made as the result of an epidemic of streptococcus tonsillitis in

which the bubble fountains were suspected to be a factor in transmitting disease. A survey of all the fountains of the University of Wisconsin showed the presence of streptococci in over 50 per cent. of the total number. The streptococci varied in abundance from a few chains to an almost pure culture obtained by swabbings from the fountains in the woman's dormitory. In an experimental bubble fountain, Bacillus prodigiosus, when introduced either by means of a pipette or by the moistened lips, remained in the water from 2 to 135 minutes, depending partly on the height of the bubble. Most of the organisms are flushed away, but some remain, dancing in the column much as a ball dances on the garden fountain, even though the bubble be increased to the impractical height of four inches. To avoid the difficulty always present in the vertical column a simple fountain with a tube at an angle of 50 degrees from the vertical was constructed. Bacillus prodigiosus was never found in the plates from this type of fountain even when samples were taken immediately after the introduction of the organism. It is believed that this type of fountain should be generally adopted. Its simplicity, low cost of construction and freedom from lurking danger should recommend it to all.

Effects of Exposure to Cold upon Experimental Infection of the Respiratory Tract.—MILLER and NOBLE (*Jour. Exper. Med.*, 1916, No. 3, xxiv) state that respiratory infection of rabbits with Bacillus bovisepticus (snuffles) is favored by chilling the animals after they have been accustomed to heat. The character of this disease, which occurs frequently in rabbits under natural conditions, make the application of the experimental results to similar respiratory conditions in man less open to objection than in similar experiments with other infections. The weight of experimental evidence, including that of the authors, does not justify the elimination of exposure to cold as a possible secondary factor in the incidence of acute respiratory disease. From the limited data of their last two experiments, they suggest that any marked change of temperature predisposes rabbits to this infection, the severity of which varies with the amount of change, and that a change from low to high temperature has even more effect than that from high to low.

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COLLEGE OF PHYSICIANS OF PHILADELPHIA

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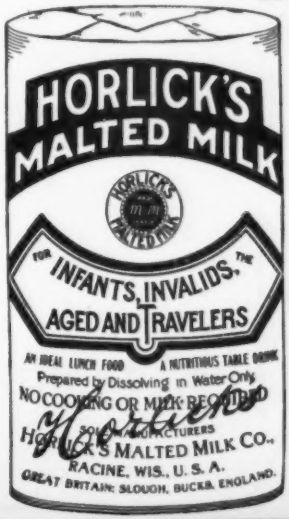
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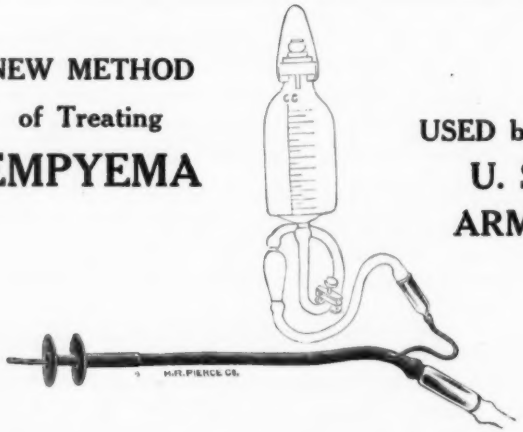

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